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DECEW FALLS GS - INVESTIGATION OF HEADPOND DYKE MATERIALS

C.B.H. Cragg

Historical records show the DeCew Falls GS dykes were originally constructed in 1895 and enlarged in the late 1940's. As soil property data from these times is insufficient for modern day stability analyses of the dykes, the soils encountered in nine (1986) piezometer holes were sampled and tested to provide data for future design reviews. The dykes generally consist of firm silty clay underlain by hard, silty clay till and limestone bedrock. Physical properties of the "old" and "new" dyke fill are quite similar. Organic material and local zones of weaker soil were encountered between the dyke fill and the foundation soil, and in the fill overlying the former waste weir structure.

1.0 INTRODUCTION

The original headpond dykes for DeCew Falls GS were constructed in the early 1890's, predating the science of soil mechanics and modern construction equipment. It is believed that the soil for these dykes was excavated from the headpond area but what method was used for compaction, if any, is not known. The records/1,2/ suggest that the "new" fill placed during the 1940's was compacted to an acceptable standard and was superior in quality to the "old" fill. Aside from the 1940's density measurements and some grouting holes driven through the soil to repair headworks leakage in the late 1960's, data on the in situ engineering properties of the dyke fill and foundation materials is lacking. At the request of the Civil Works Department, a soils investigation was undertaken during the installation of monitoring instruments late in 1986/3/. The instrument holes were located where seepage was observed in the Forebay Dyke and at the highest fill location in the Waterworks Canal Dyke. Soil properties obtained from this investigation are summarized in this report.

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2.0 FIELD PROGRAM

Nine boreholes were drilled in the headpond dykes. Eight were located in the Forebay dykes (Figure 1) and one in the Waterworks Canal dyke (Figure 2).

Piezometers were installed at all nine locations. Boreholes 1 to 7 were located at known seepage zones in the Forebay dykes. Borehole 9 was situated atop the former waste weir to investigate the cause of surface settlement in this short stretch of dyke. Borehole 8 was drilled at the highest section of the Waterworks canal dyke.

In the dyke fill, Shelby tube samples were taken at 3 foot intervals and in situ vane tests were normally performed between each sample. Split spoon samples were generally taken at 3 foot intervals in the foundation soil (native till), using the Standard Penetration Test method. At Boreholes 1 and 6, bedrock was cored for a depth of 5 feet below the soil/rock contact, using a NQ bit. Boreholes 2, 4 and 7 were taken to refusal on presumed bedrock. Borehole 9 was drilled to refusal on top of the old concrete Waste Weir structure. Boreholes 3, 5 and 8 terminated at design piezometer depths of 25 feet, 25 feet and 35 feet, respectively, in soil.

3.0 LABORATORY TESTING

All samples were subjected to shear strength, bulk density, water content and visual classification tests. From these samples, materials representing the different dyke fill and weaker natural soil zone were selected for four consolidation tests, three triaxial c'-Ø' test sets, and three triaxial permeability tests. All triaxial work was performed by an external consultant as the Civil Research facility was being moved at the time of this project. Results of the field and laboratory tests are summarized in the borehole logs (Figures 3 to 11).

4.0 INTERPRETED SUBSOIL STRATIGRAPHY

Boreholes 1 to 7 have been assembled into two interpreted cross sections of the Forebay dyke on Figures 12 and 13. These sections agree with the information available in the design drawings (Dwg No 47-e-337, Section E) by finding silty clay (fill) over natural silty clay till but augment this data by finding the depth to bedrock, and the presence of organic materials at some locations, as detailed below. Borehole 8 confirmed the presence of silty clay (fill) throughout the Waterworks Canal dyke as shown on Figure 15.

At Boreholes 1, 2, 4 and 6 which were drilled through the Forebay dyke, silty clay (fill) was found to a depth of 25 feet. The silty clay (fill) was underlain by about 10 feet of silty clay till and then bedrock. Boreholes 3 and 5, also in the Forebay dyke, found silty clay (fill) and did not penetrate into the underlying till as they were terminated at a depth of 25 feet. Silty clay (fill) was also found for the full depth of boreholes 8 (Waterworks Canal dyke) and 9 (Waste Weir-Forebay dyke). Borehole 7, at the toe of the Forebay dyke, encountered silty clay till until refusal occurred at the 15 foot depth. Organic-rich silty clay (topsoil) was found between the fill and the till in Boreholes 1, 2 and 5. At Borehole 9, organic material and wood was found in the fill. The engineering properties of these strata are described in the following sections.

5.0 ENGINEERING PROPERTIES OF DECEW FALLS SOILS

Routinely measured soil properties have been extracted from the borehole logs (Figures 3 to 11) and summarized in profile format for easy reference. Figures 15 and 16 show water contents. Figures 17 and 18 show bulk densities. Figures 19 and 20 show laboratory shear strength measurements. All forms of undrained shear strength testing have been employed to obtain the shear strength values (ie unconfined, unconsolidated undrained and consolidated undrained). The reader should refer to the borehole logs to determine the type of test used and give consideration to this in selecting values for design use.

5.1 Dyke Fill - Index Tests

The clean clayey silt fill has bulk density values ranging from 118 to 130 lb/ft^3, water content values between 17% and 31%, and laboratory shear strength values ranging from 530 psf to 3800 psf. Field vane measured shear strengths were generally much higher than the laboratory values (Figures 3 to 11). From Figures 15 and 16 it may be seen that moisture content values are generally clustered around the 25% value. The anomalous higher values represent zones where organic fill (Borehole 9 and 5) or organic foundation soil (topsoil - Boreholes 1, 2 and 5) were obtained. Low bulk density values (typically less than 110 lb/ft^3) were usually measured at the same locations as the high moisture contents (Figures 17 and 18). These samples frequently also had low shear strength values. For the organic soils, field vane shear strengths were again higher than laboratory shear strength values.

At a depth of 21 feet in Borehole 6, a thin wet seam was encountered which may be connected to the observed seepage at the dyke toe. No other obvious seepage zone was identified in these boreholes. The portions of Boreholes 3 and 5 below the 10 foot depth were drilled through "old" fill material, according to construction drawings. Some small portion of Boreholes 1, 2, 4 and 6 were also in this fill. All of Borehole 8 is in "old" fill material. In no observable way is this "old" fill distinguishable from the "new" fill found in these boreholes.

5.2 Dyke Fill - Special Tests

Consolidation tests on the fill (Figures 21 to 24) yielded preconsolidation pressures ranging from 2190 psf to 5530 psf. As may be seen from Table I, the organic soil had the lowest preconsolidation pressure (2190 psf) and was slightly overconsolidated with an OCR of approximately 1.38. Old fill from the Waterworks Canal dyke and the Forebay dyke had similar preconsolidation pressures and almost identical OCR values. These values were greater than those for the organic soil but less than for the new fill which had a preconsolidation pressure of 5530 psf and roughly 2.84 for an OCR value.

Table I also shows results of two triaxial permeability tests on organic and "old" (Waterworks Canal) fill material. Both materials behaved similarly with permeability values near 2×10^{-8} cm/sec. These soils are about one order of magnitude less permeable than the foundation soils tested previously from the Waterworks Canal dyke/4/. Ingles/5/ has stated that dams constructed of low

permeability (10^{-8}) material are susceptible to slope failures while those built of higher (10^{-5}) material are susceptible to seepage problems. Details of the permeability tests are contained in Appendix A.

Isotropically consolidated, undrained triaxial (CIU) tests were performed on "old" and "new" fill materials but not on the organic material. Details of this testing are contained in Appendix B. The triaxial results are analyzed by p-q, Mohr effective stress and Mohr total stress methods on Figures 25, 26 and 27. A summary of these analyses is given in Table II. The p-q analysis indicates the clayey silt fill materials are entirely frictional soils (ie zero cohesion) while the Mohr analyses show these materials display both friction and cohesion strength components (Table II). The strength parameters are highly variable between different materials within each analysis and between different analyses of the same material. Values obtained by total stress analysis show the least discrepancy between materials. Figures 25, 26 and 27 show inconsistent behaviour within each triaxial test set, with the Mohr interpretations showing the most variation. The only relatively consistent pattern shown by these tests is that the "new" fill is strongest, followed by the "old" Waterworks Canal fill and the "old" Forebay fill is weakest.

In view of the wide range of strength values obtained, further testing is recommended to substantiate the correct shear strength parameters for use in design reviews.

6.0 SUMMARY

Sampling and testing of soils encountered at instrumentation boreholes found the clayey silt dyke material to be underlain by competent clayey silt till and limestone bedrock. Zones of weaker, wetter, less dense organic materials were found in the fill over the former waste weir (which may be the cause of local dyke settlement) and at the contact between the dyke fill and foundation soils. Aside from one thin wet seam in one sample, no evidence was found of the seepage observed in the dyke near the borehole locations. Index properties showed no consistent differences between "old" and "new" dyke fills, contrary to past opinions on these materials, but consolidation tests and triaxial shear strength tests suggest that the "new" fill is stronger.

Further triaxial testing is recommended to refine the strength values to use in future design reviews.

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2. Peden, J.D. "DeCew Falls GS Weekly Progress Report Period Ending July 17, 1968". Civil Works files, 1968.

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4. Toth, P. "DeCew GS Headpond Slope Stability Investigation". Research Division Report No 86-251-K, 1986.

5. Ingles, O.G. "Statistics and Probability: The Engineer-Client Interaction Problem". Paper presented to 5th International Conference on Applications of Statistics and Probability in Soil and Structural Engineering, Vancouver, BC, May 25-29, 1987.

TABLE I

Summary of Special Tests at DeCew Falls GS (1986)

	CONSOLIDATION TESTS				PERMEABILITY TESTS		
Material	Sample No	Depth (ft)	P_c' (psf)	OCR	Sample No	Depth (ft)	K (cm/sec)
old fill (Forebay)	BH.5 S-5	16	3130	2.24	BH.5 S-5	16	not testable
old fill (Water-works)	BH.8 S-5	16	3650	2.28	BH.8 S-7	22	2.5×10^{-8}
organic fill (Forebay)	BH.5 S-6	19	2190	1.38	BH.5 S-6	19	1.5×10^{-8}
new fill (Forebay)	BH.6 S-7	21	5530	2.84	-	-	-

NOTES: P_c' = preconsolidation pressure
OCR = overconsolidation ratio (P_c'/P_o)
k = permeability

TABLE II

DeCew Falls GS - 1986 Triaxial Test Summary

Material	Source	Shear Strength Parameters: p-q Ø'	p-q c'	Mohr (effective) Ø'	Mohr (effective) c'	Mohr (total) Ø'	Mohr (total) c'	Test Set No
"old" fill (Forebay)	BH.3 S-5,-6	27°	0	17.5°	16	15.5°	27	1
"old" fill (Waterworks)	BH.8 S-8,-9	30.5°	0	28°	11	17.5°	31	3
"new" fill (Forebay)	BH.4 S-7	36°	0	28°	17	20°	20	2

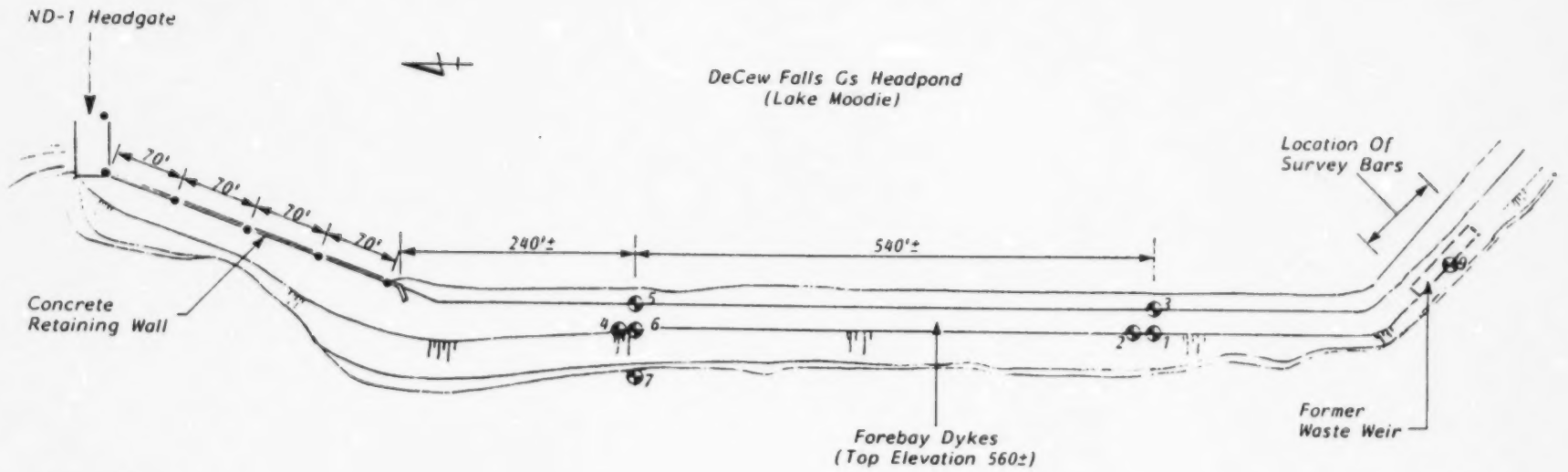

FIGURE 1

DECEW FALLS GS
INSTRUMENT LOCATIONS ON
FOREBAY DYKES

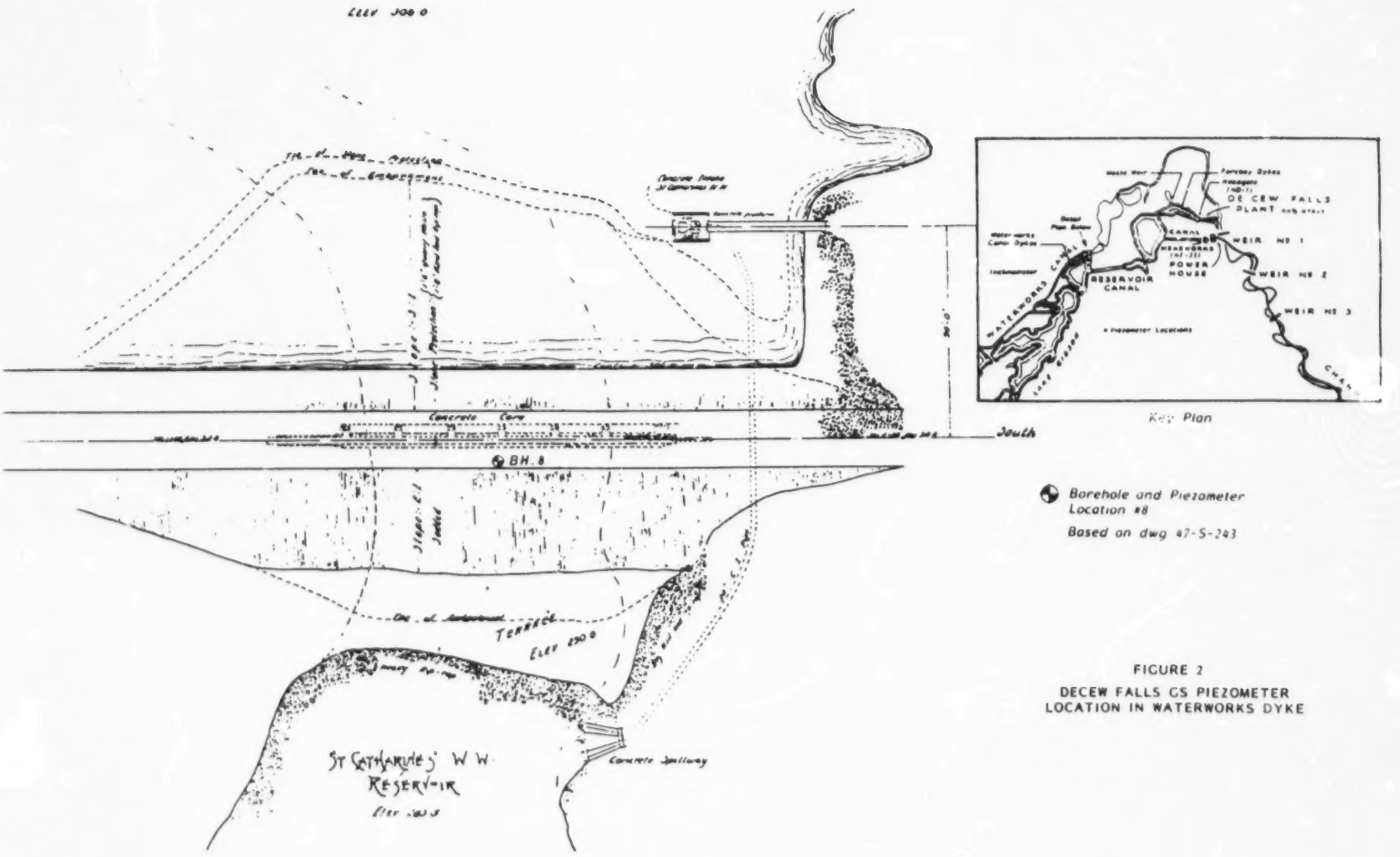

FIGURE 2

DECEW FALLS GS PIEZOMETER
LOCATION IN WATERWORKS DYKE

PROJECT DECEW FALLS GS — HOLE TYPE FLYTE AUGER — OBSERVER PA

LOCATION FOREBAY DYKES (SEE FIGURE 1) — HOLE SIZE 4" — COMPILED CBC

DIP — DRILLED OCT 20/86 — CHECKED

DATUM — BEARING — DRAWN — APPROVED

BORING DATA					BORING LOG		WATER INF		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						FILL, Silty Clay, Firm to Stiff, Brown, Damp, Frequent Zones With a Trace of Fine Gravel											
4		B1		PUSH								121	25.6	uc	760		
												126.8	21.3	qu	1952		
6										FV	2815						
		B2		"								125.9	22.5	uc	2611		
8										FV	3312						
10		B3		"								120.4	24.9	uc	1316		
12										FV	5410						
		B4		"								125.3	22.5	uc	1314		
14										PV	3753						
		B5		"								121	25.1	uc	531		
16												123	23.9	qu	1113		
18										FV	2926						
		B6		"								121	26.4	qu	1206		
20										FV	4306						
22		B7		"		Change to Grey at 22'						125.4	25.2	qu	1517		
						24.0'											
24		B8		"		SILTY CLAY (Topsoil), Some Organics, Stiff, Dark Grey						104	49.6	qu	1860		
26						27.0'											
28		B9		"		SILTY CLAY TILL, Hard, Trace of Fine Gravel, Brown to Grey-Brown						130	21.2	uc	3464		
30		A10		66								132	14.5	uc	10403		
32																	
34		A11		94								136.8	15.4	uc	9515		
						35.6'											
36						BEDROCK, Limestone	PIEZOMETER - 3 ft screen - tip at 40.6' - 1¼" PVC pipe											
38		NQ															
						40.6'											
40						END OF BOREHOLE											
42																	
44																	

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GEOTECHNICAL DATA SHEET

hole no 1 — Fig 3

sheet 1 of 1

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PROJECT DECEW FALLS GS — HOLE TYPE FLYTE AUGER — OBSERVER PA

LOCATION FOREBAY DYKES — HOLE SIZE 4" — COMPILED CBC

(SEE FIGURE 1) — DIP — DRILLED OCT 21/86 — CHECKED

DATUM — BEARING — DRAWN — APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING / W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						FILL, Silty Clay, Firm to Stiff Odd Seam With Traces of Sand and Fine Gravel, Brown, Damp												
4		B1		PUSH								119	27	uc	923		
												129	19.6	qc	1540		
6										FV	2564						
		B2		"								126	23	qu	1483		
8										FV	2590+						
10		B3		"								124	24.2	qu	1934		
12		B4		"								127	22.7	uc	2005		
14							PIEZOMETER - 3 ft screen - tip at 38.5' - 1¼" PVC Pipe										
16		B5		"								123	28.7	qu	951		
18		B6		"								123	26.4	qu	1020		
20																	
22		B7		"									19.5				
						24.0'											
24		B8		"		SILTY CLAY, (Topsoil) Some Organics, Grey						109	38.6 48.5	cu	1721		
26						27.0'											
		B9		"		SILTY CLAY TILL, Hard, Brown, Occasional Trace of Fine Gravel, Fissured at Depth						127	24.2	uc	1504		
28																	
30		A10		74								134	18	uc	8563		
32																	
		A11		84								133	17.8	uc	9061		
34																	
36		A12		86								138	15.4	uc	4870		
38						38.5'											
						END OF BOREHOLE											
40						(Auger Refused on Assumed Bedrock)												

GEOTECHNICAL DATA SHEET

hole no 2 — Fig 4

sheet 1 of 1

PROJECT DECEW FALLS GS — HOLE TYPE FLYTE AUGER — OBSERVER PA

LOCATION FOREBAY DYKES (SEE FIGURE 1) — HOLE SIZE 4" — COMPILED CBC

DIP — DRILLED OCT 22/86 — CHECKED

DATUM — BEARING — DRAWN — APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING / W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS. TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						FILL. Silty Clay, Stiff, Frequent Zones With a Trace of Fine Gravel, Brown, Damp											
4		B1		PUSH						FV	4200	128.4	21.5	uc	3802		
6		B2		"								127	21.3	uc	1548		
8										FV	15550						
10		B3		"								123	25.3	qu	1581		
12		B4		"						FV	7150	125	23.7	qu	1577		
14										FV	4970						
16		B5		"								125	23.7				
18		B6		"				PIEZOMETER - 1¼" PVC pipe - tip at 24.5'		FV	3580	126	25.1				
20										FV	4660	124	23.5				
22		B7		"								126	24.8	qu	1099		
24						25.0'				FV	9640						
26						END OF BOREHOLE											
28																	
30																	

GEOTECHNICAL DATA SHEET — hole no 3 — Fig 5 — sheet 1 of 1

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PROJECT ... DECEW FALLS GS ... HOLE TYPE ... FLYTE AUGER ... OBSERVER ... PA

LOCATION ... FOREBAY DYKES ... HOLE SIZE ... 4" ... COMPILED ... CBC

(SEE FIGURE 1) ... DIP ... DRILLED ... OCT 23/86 ... CHECKED

DATUM ... BEARING ... DRAWN ... APPROVED

BORING DATA						BORING LOG	WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING	(5) DESCRIPTION / (6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						*FILL, Silty Clay, Firm to Stiff, Brown, Damp*										
4		B1		PUSH					FV	5600	129.7	18.5	uc	2194		
6		B2		"							124.6	24.1	uc	1232		
8									FV	4820						
10		B3		"		*Trace Fine to Coarse Gravel at 21' - 23'*					126.0	23.2	uc	1345		
12						*Fissured Below 24'*			FV	4980						
14		B4		"							122.0	25.6	qu	1132		
16		B5		"					FV	4510	125.0	23.7	qu	1581		
18		B6		"					FV	5130	124.0	27.1	qu	529		
20											126.0	24.4	cu	2040		
22		B7		"		*PIEZOMETER - 1¼" PVC pipe - tip at 35'*			FV	6060	128.0	30.8 23.4	cu	1878		
24									FV	6840						
26		B8		"		*25.6'*					129.8	20.6	uc	2998		
28		A9	X	88							135.8	17.1	uc	10 549		
30		A10	X	104		*SILTY CLAY TILL, Hard, Brown, Trace of Fine Gravel*					137.7	15.9	uc	10 377		
32		A11	X	92							140.0	12.6				
34						*35.5'*										
36						*END OF BOREHOLE (Auger Refusal on Assumed Bedrock)*										
38																
40																

GEOTECHNICAL DATA SHEET

hole no 4 | Fig 6

sheet 1 of 1

PROJECT ... DECEW FALLS GS ... HOLE TYPE ... FLYTE AUGER ... OBSERVER ... PA

LOCATION ... FOREBAY DYKES ... HOLE SIZE ... 4" ... COMPILED ... CBC

(SEE FIGURE 1) ... DIP ... DRILLED ... OCT 28/86 ... CHECKED ...

DATUM ... BEARING ... DRAWN ... APPROVED ...

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING W.L. / C.R.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS psf TYPE	(11) SPECIAL TESTS psf RESULTS
2						*FILL Silty Clay, Firm to Stiff Occasional Trace of Sand and Fine Gravel*											
4	B1		PUSH									126	23.0	uc	2802		
6										FV	9020						
8	B2		"									125	23.5	uc	1811		
10	B3		"							FV	6060						
12													21.8			PP	1100
14	B4		"							FV	4820						
16	B5		"				*PIEZOMETER* → *- 1¼" PVC pipe - tip at 25'*					125	26.6 24.2	cu	1874		
18						*16.0'*				FV	3580	118	30.7 18.9	cu	872		
20	B6		"			*SILTY CLAY (Topsoil), Little to Some Organics, Very Soft to Firm, Trace Fine Gravel, Dark Grey to Grey, Damp to Wet*				FV	4200	117	31.2 26.0	cu	519	K	1.5×10^{-8} cm/s
22	B7		"							FV	4800	115	29.3 34.8	cu	200		
24						*25.0'*				FV	2800						
26						*END OF BOREHOLE*											
28																	
30																	

GEOTECHNICAL DATA SHEET

hole no 5 | Fig 7

sheet 1 of 1

PROJECT ..... DECEW FALLS GS ..... HOLE TYPE FLYTE AUGER OBSERVER PA

LOCATION ..... FOREBAY DYKES ..... HOLE SIZE 4" COMPILED CBC

(SEE FIGURE 1) DIP ..... DRILLED OCT 27/86 CHECKED

DATUM ..... BEARING ..... DRAWN ..... APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD - %	(4) WATER LEVEL and CAVING W.L.	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
	2					*FILL, Silty Clay, Firm to Stiff, Brown, Damp, Frequent Zones with Trace Fine Gravel*											
	4	B1		Push		*Change to Grey at 18'*						127	17.2	uc	1568		
	6	B2		"								125	23.6	uc	1198		
	8																
	10	B3		"								125	25.7	qu	812		
	12	B4		"		*More Gravel and Wet Seam (Suspected Seepage Path) at 21'*						123	25.6	uc	806		
	14																
	16	B5		"								126	23.0	uc	1809		
	18	B6		"								124	24.6	cu	1748		
	20																
	22	B7		"									26.0			PP	1450
	24	B8		"								122	25.2	cu	1623		
	25.7'																
	26					*SILTY CLAY TILL, Hard, Brown, Occasional Silt Partings, Trace Fine Gravel*											
	28	A9		60								136	20.8				
	30																
	32	A10		67								134	18.7	uc	6224		
	34	A11		86								142	14.6				
	35.5'																
	36					*BEDROCK, Limestone*											
	38	NQ															
	40																
	40.7'					*END OF BOREHOLE*											
	42																

PIEZOMETER
- 1¼" PVC pipe
- tip at 40.5'

dwg no

GEOTECHNICAL DATA SHEET

hole no 6 | Fig 8

sheet 1 of 1

PROJECT .... DECEW FALLS GS ..... HOLE TYPE FLYTE AUGER OBSERVER PA

LOCATION .... FOREBAY DYKES ..... HOLE SIZE 4" COMPILED CBC

(SEE FIGURE 1) DIP ..... DRILLED OCT 28/86 CHECKED

DATUM ..... BEARING ..... DRAWN ..... APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD-%	(4) WATER LEVEL and CAVING W.L	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
2						SILTY CLAY TILL, Hard, Brown, Trace Fine Sand											
4		B1		Push								131	21.5	uc	3089		
6		A2		54								135	17.3	uc	10,351		
8																	
10		A3		53								134	17.9	uc	8259		
12							PIEZOMETER →					134	17.8	uc	4021		
14		A4		57			- 1¼" PVC pipe - tip at 15'										
16						15.0 END OF BOREHOLE (Auger Refusal on Assumed Bedrock)											
18																	
20																	

GEOTECHNICAL DATA SHEET

hole no 7 | Fig 9

sheet 1 of 1

PROJECT ... DECEW FALLS GS ... HOLE TYPE FLYTE AUGER OBSERVER PA

LOCATION ... WATERWORKS CANAL DYKES ... HOLE SIZE 4" COMPILED CBC

... (SEE FIGURE 2) DIP ... DRILLED ... OCT 28/86 CHECKED

DATUM ... BEARING ... DRAWN ... APPROVED

BORING DATA						BORING LOG		WATER INF.		FIELD TESTS		LABORATORY TESTS					
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / ROD-%	(4) WATER LEVEL and CAVING / W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' cm/s / WATER PRESS TEST	(9) SPECIAL TESTS TYPE	(9) SPECIAL TESTS RESULTS psf	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS
	2					*FILL, Silty Clay to Clayey Silt Firm to Stiff, Brown, Trace Fine Gravel*											
	4	B1		PUSH								126	21.9	uc	1943		
	6	B2		"								127	21.7	uc	1700		
	8																
	10	B3		"								123	25.4	uc	1586		
	12																
	14	B4		"								126	23.7	uc	1442		
	16	B5		"								120	29.0	uc	1017		
	18																
	20	B6		"								125	24.9	qu	1456		
	22	B7		"								123	26.3	qu	469	k	2.5×10^{-2} cm/s
	24	B8		"								125	24.3 27.2	cu	2129		
	26																
	28	B9		"								126	24.8	qu	1846		
	30	B10		"			PIEZOMETER - 1¼" PVC pipe - tip at 35'					127	23.7	cu	1437		
	32																
	34	B11		"		35.0'						124	25.9	qu	979		
	36					END OF HOLE											
	38																
	40																

GEOTECHNICAL DATA SHEET

hole no 8 Fig 10

sheet 1 of 1

PROJECT DECEW FALLS GS — HOLE TYPE FLYTE AUGER — OBSERVER PA

LOCATION FOREBAY DYKES (SEE FIGURE 1) — DIP — HOLE SIZE 4" — DRILLED NOV 4/86 — COMPILED CBC

DATUM — BEARING — DRAWN — CHECKED — APPROVED

BORING DATA						BORING LOG		WATER INF		FIELD TESTS		LABORATORY TESTS				
SCALE - FEET	ELEV / DEPTH	(1) SAMPLE NO	(2) SAMPLE TYPE	(3) 'N' VALUE per 0.3m / RQD - %	(4) WATER LEVEL and CAVING / W.R	(5) DESCRIPTION	(6) REMARKS	(7) OBSERVATION WELL DATA	(8) 'k' soil/rock cm/s / WATER PRESS TEST	(9) SPECIAL TESTS psf TYPE	(9) SPECIAL TESTS psf RESULTS	NATURAL DENSITY pcf	MOISTURE CONTENT - %	(10) SHEAR STRENGTH psf TYPE	(10) SHEAR STRENGTH psf RESULTS	(11) SPECIAL TESTS TYPE	(11) SPECIAL TESTS RESULTS psf
2						*FILL*, Silty Clay, Firm to Stiff, Damp, Brown, With Some Organics and Pieces of Rotten Wood								74.4			PP	960
4		B1		PUSH									48.1				
6		B2		"			PIEZOMETER →					103	41.0	cu	756		
8							- 1¼" PVC pipe						42.8				
10						10' END OF BEDROCK	- tip at 10'										
						Refusal on Buried Concrete Structure (Waste Weir)											

GEOTECHNICAL DATA SHEET

hole no 9 — Fig 11

sheet 1 of 1

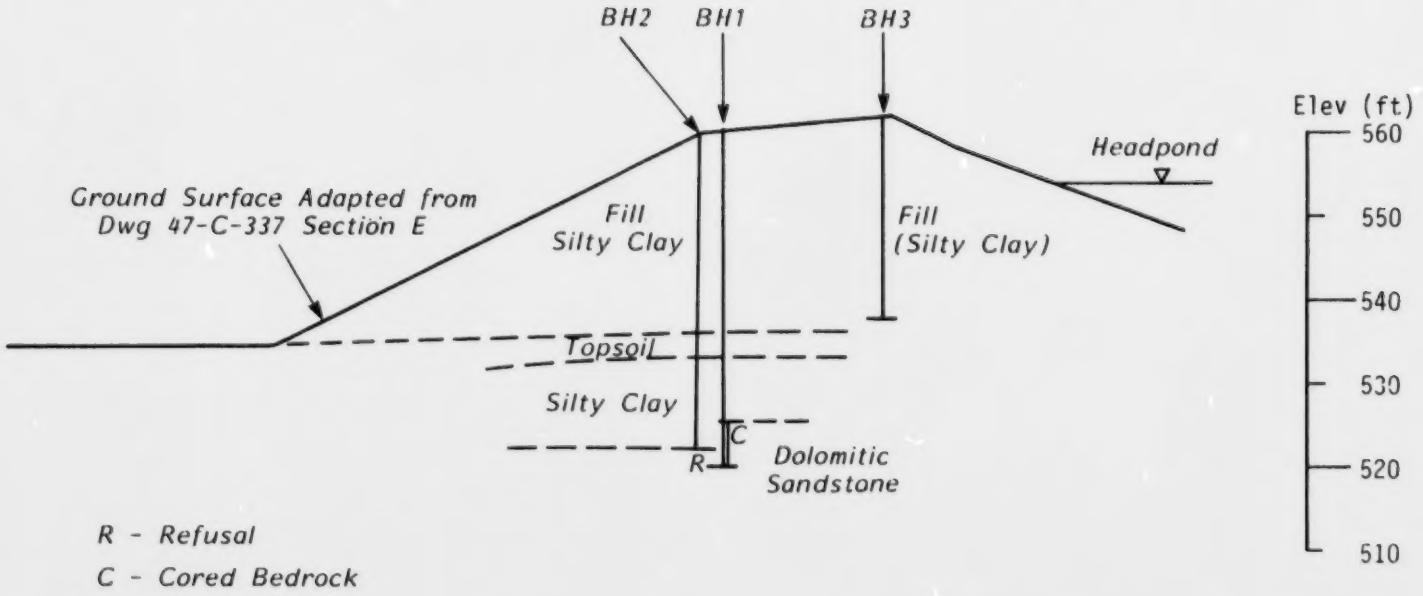


FIGURE 12

DECEW FALLS FOREBAY DYKE
CROSS-SECTION "A"

176393-RD
88-6

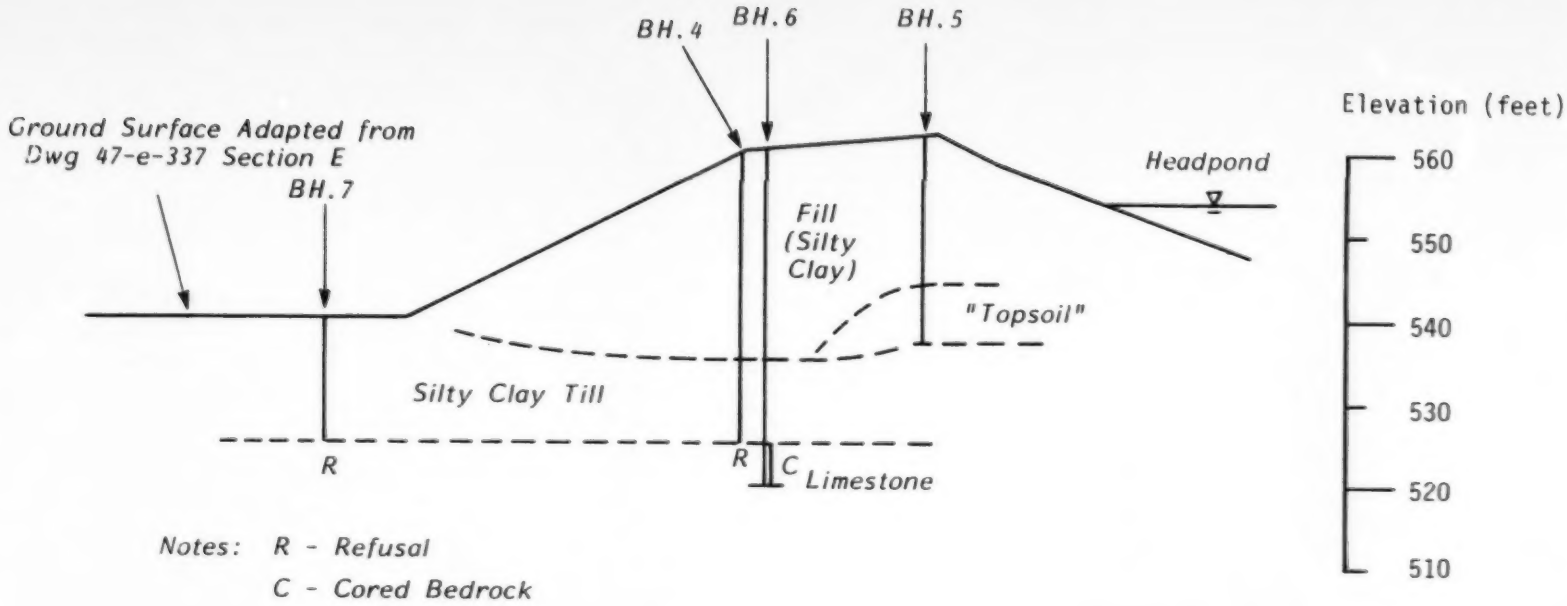
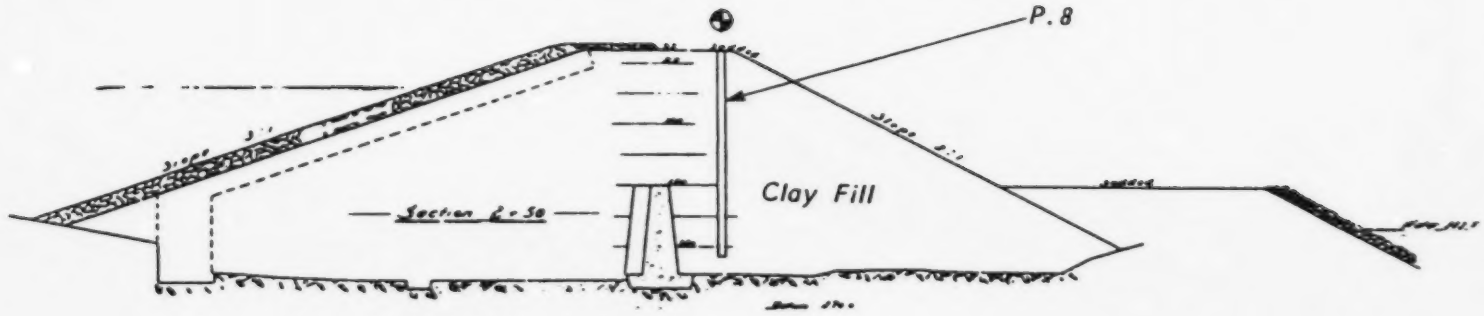


FIGURE 13
DECEW FALLS FOREBAY DYKE
CROSS-SECTION B



Piezometer And
Borehole Location #8

FIGURE 14

DECEW FALLS GS
SECTION OF WATERWORKS
CANAL DYKE

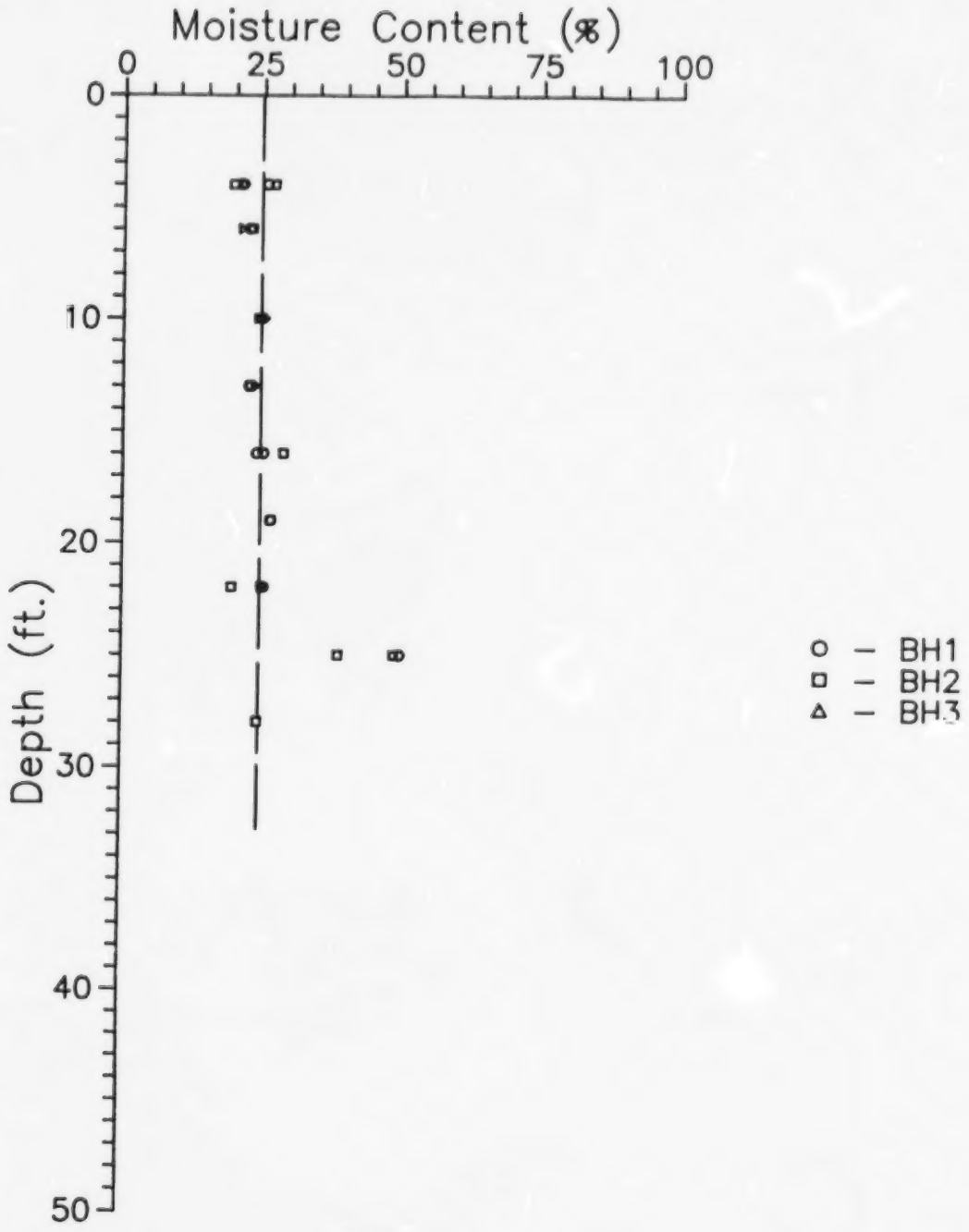


FIGURE 15
WATER CONTENT SUMMARY-BH1-3

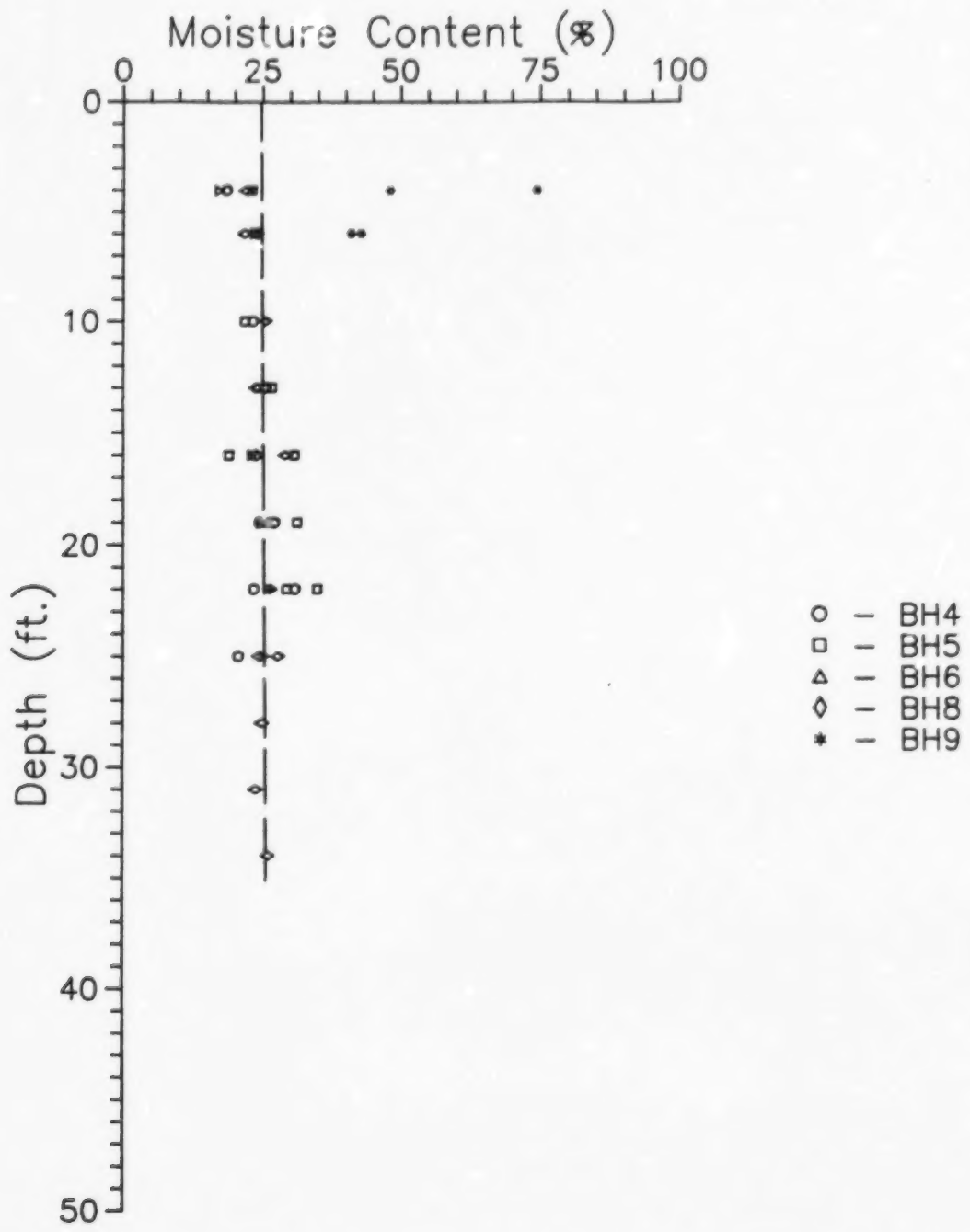


FIGURE 16

WATER CONTENT SUMMARY - BH4-9

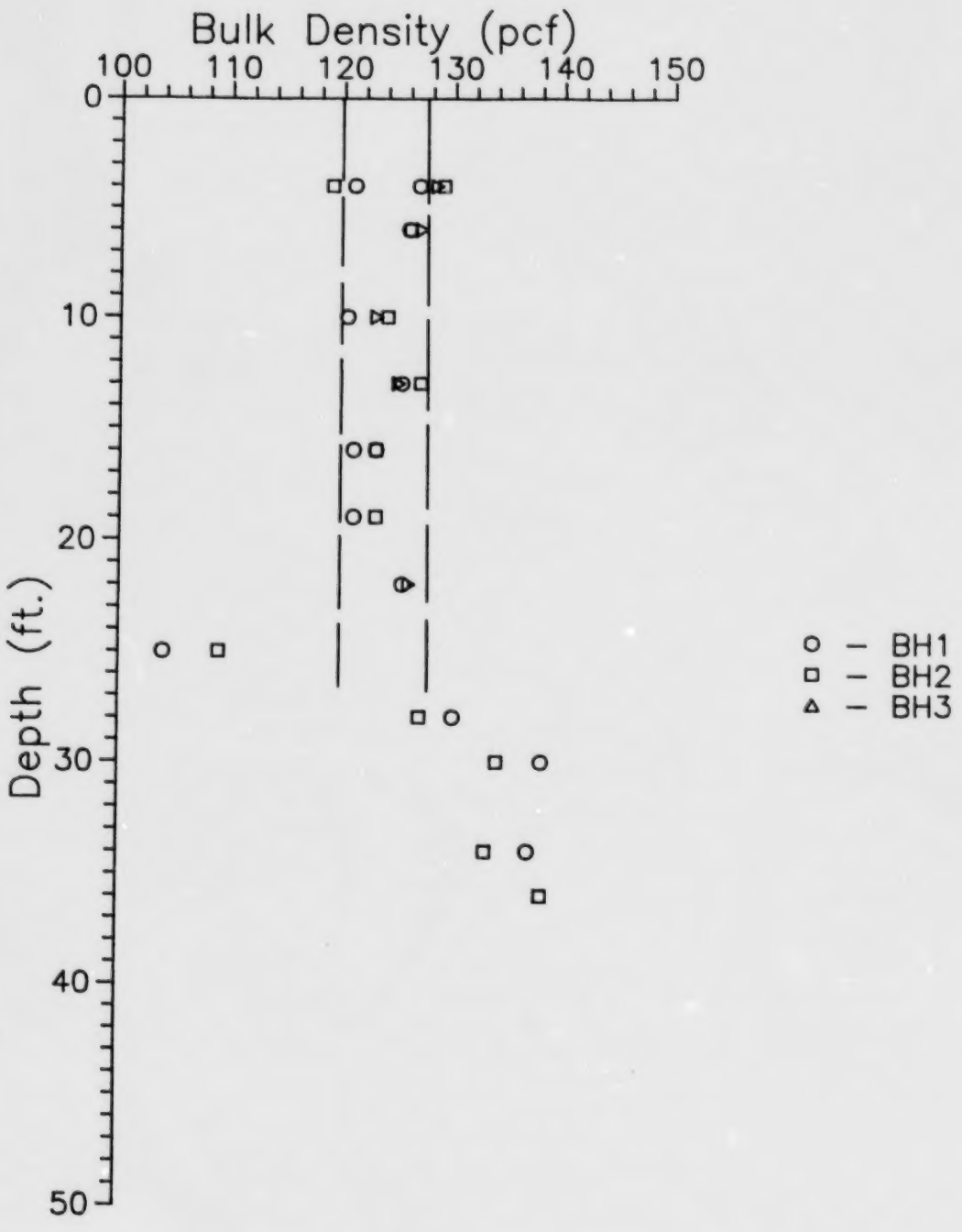


FIGURE 17
BULK DENSITY SUMMARY - BH1-3

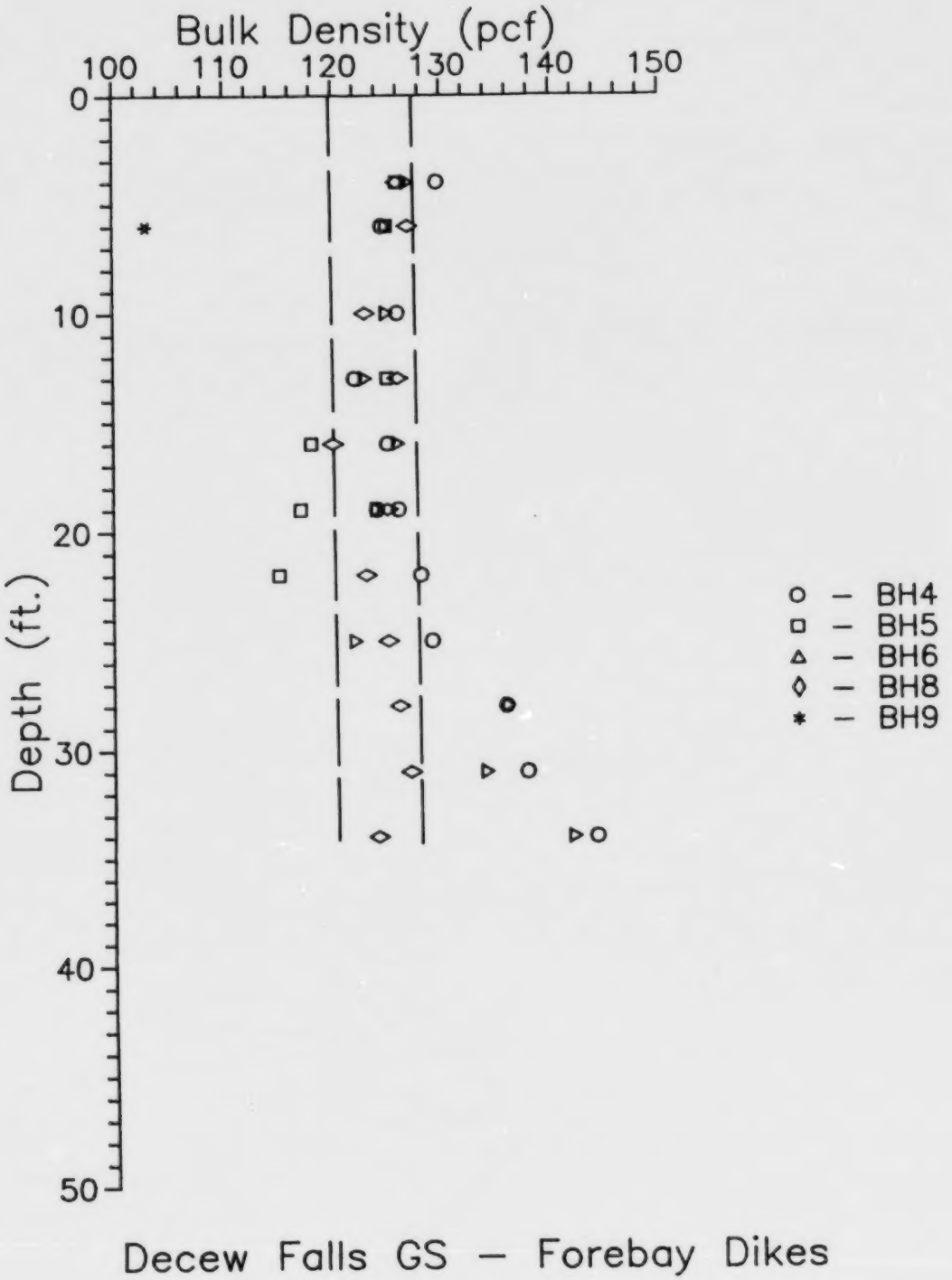


FIGURE 18
BULK DENSITY SUMMARY - BH4-9

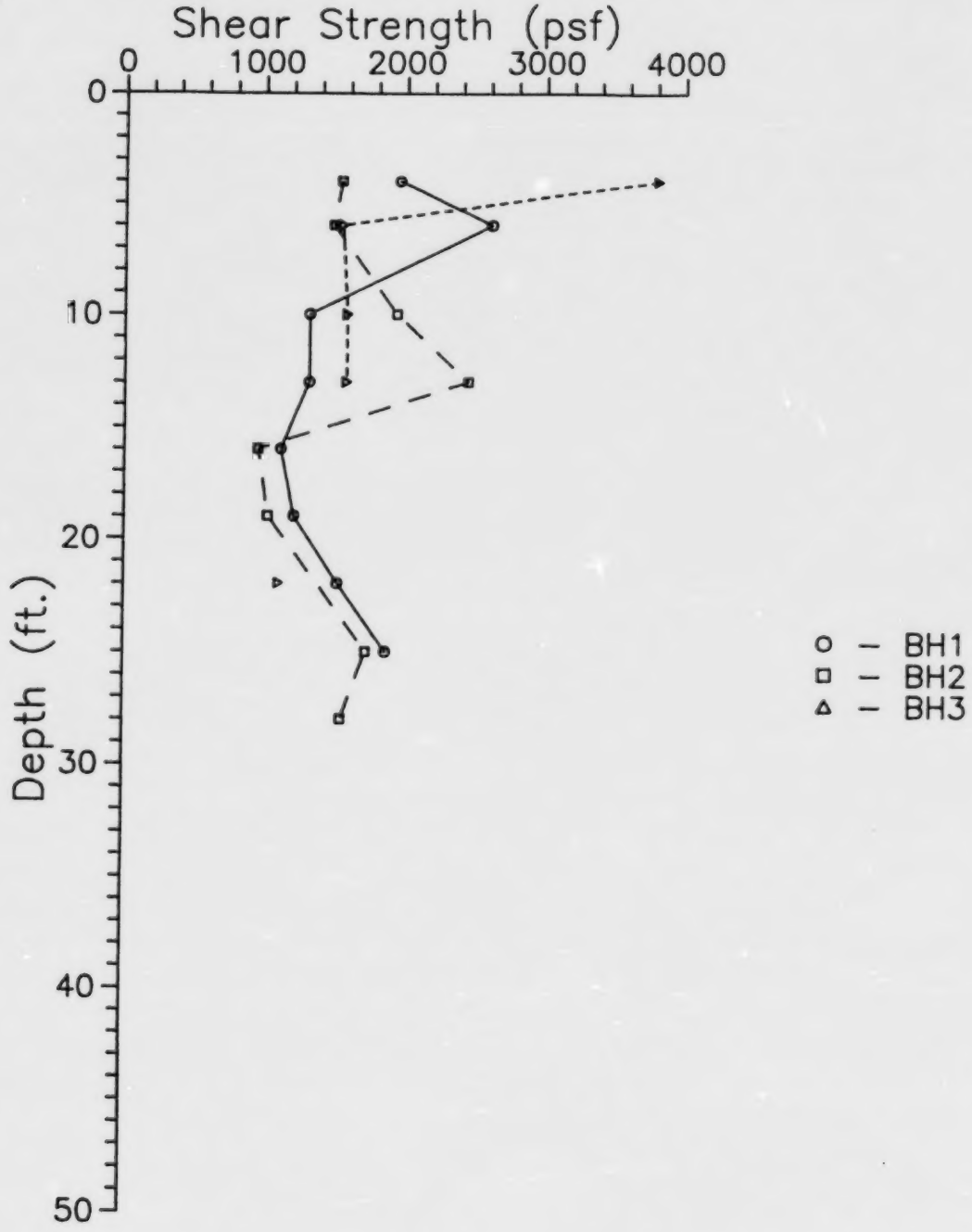


FIGURE 19

LABORATORY SHEAR STRENGTH SUMMARY - BH1-3

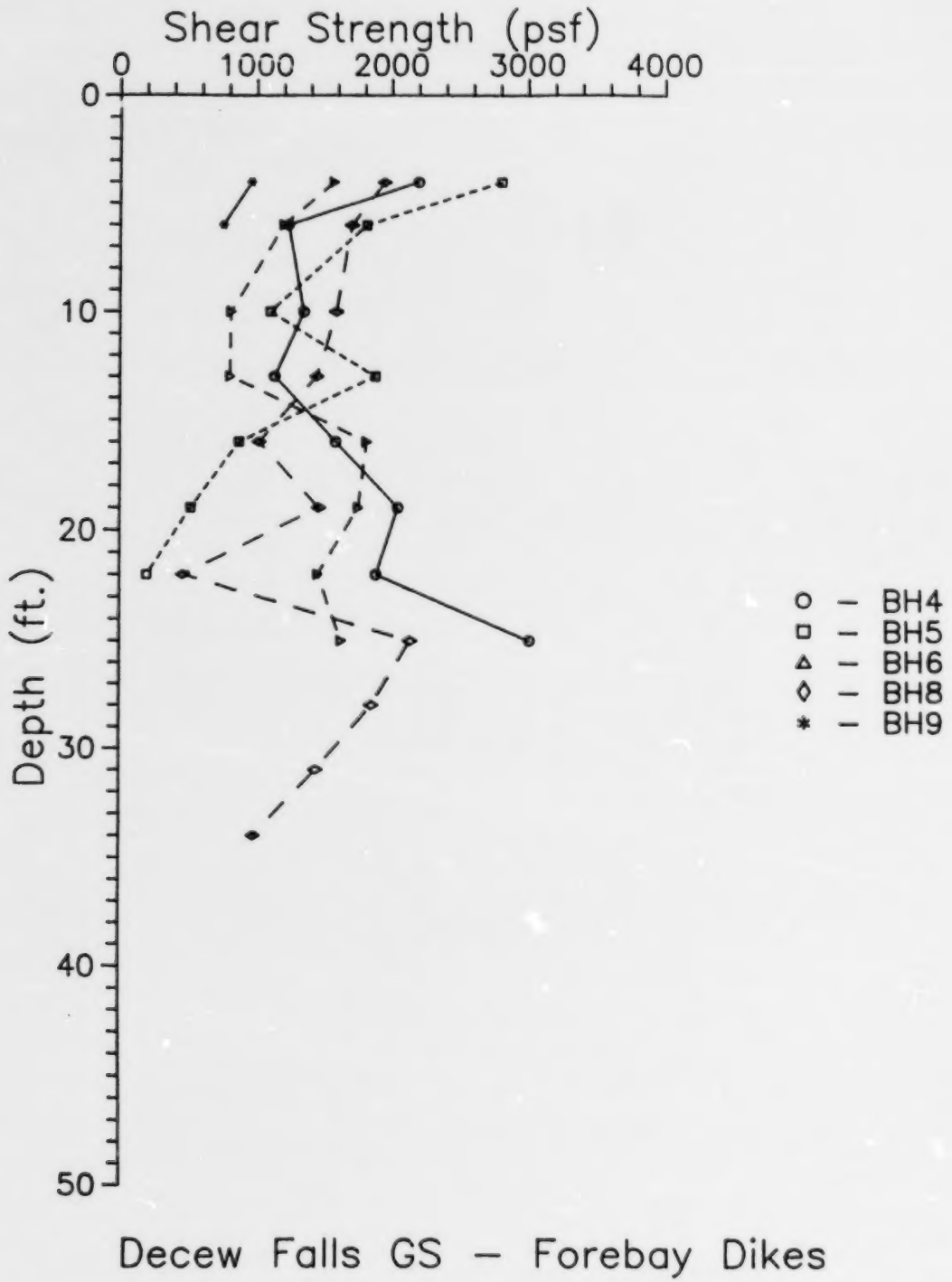


FIGURE 20

LABORATORY SHEAR STRENGTH SUMMARY - BH4-9

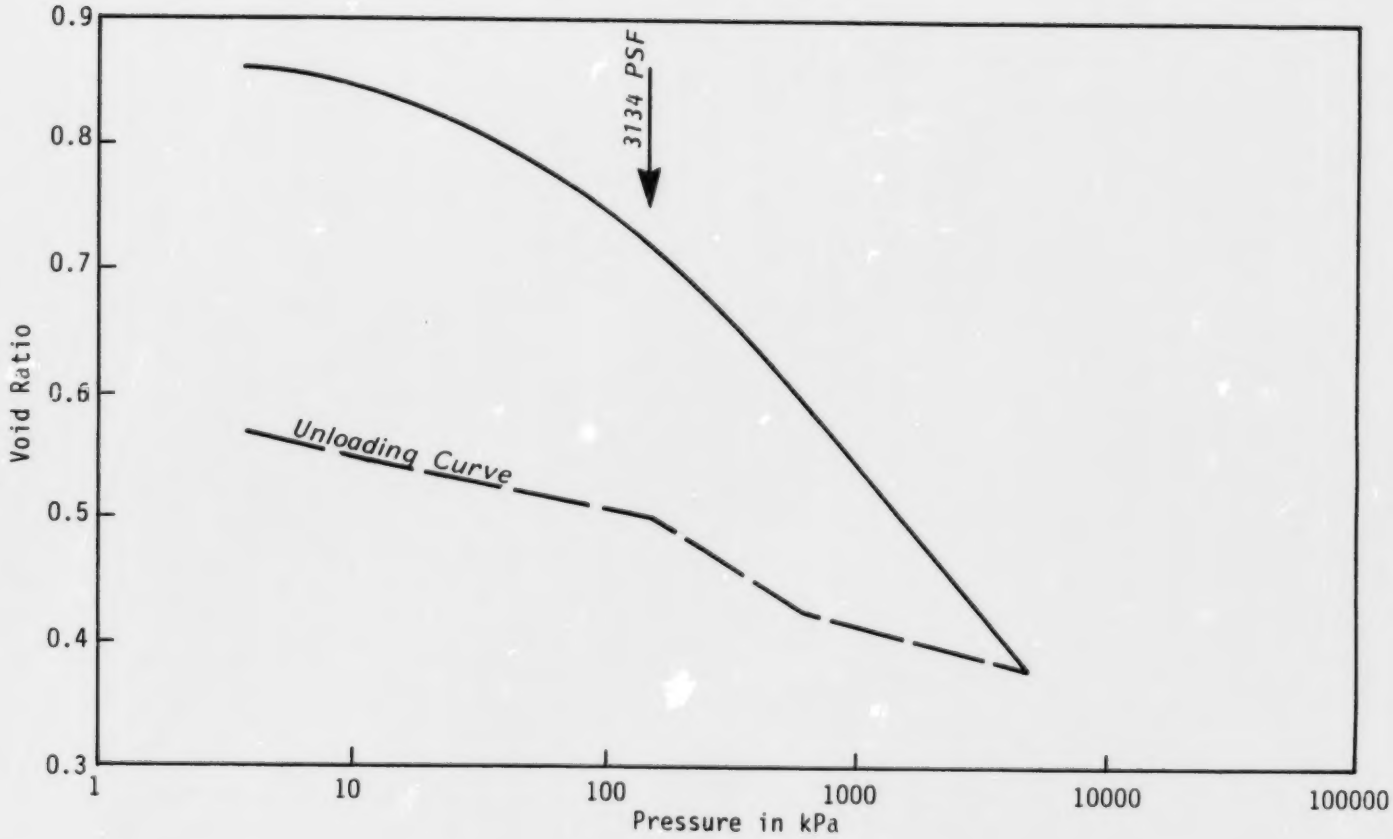


FIGURE 21

DECEW FALLS GS
CONSOLIDATION TEST
(BH.5, S-5, 16')

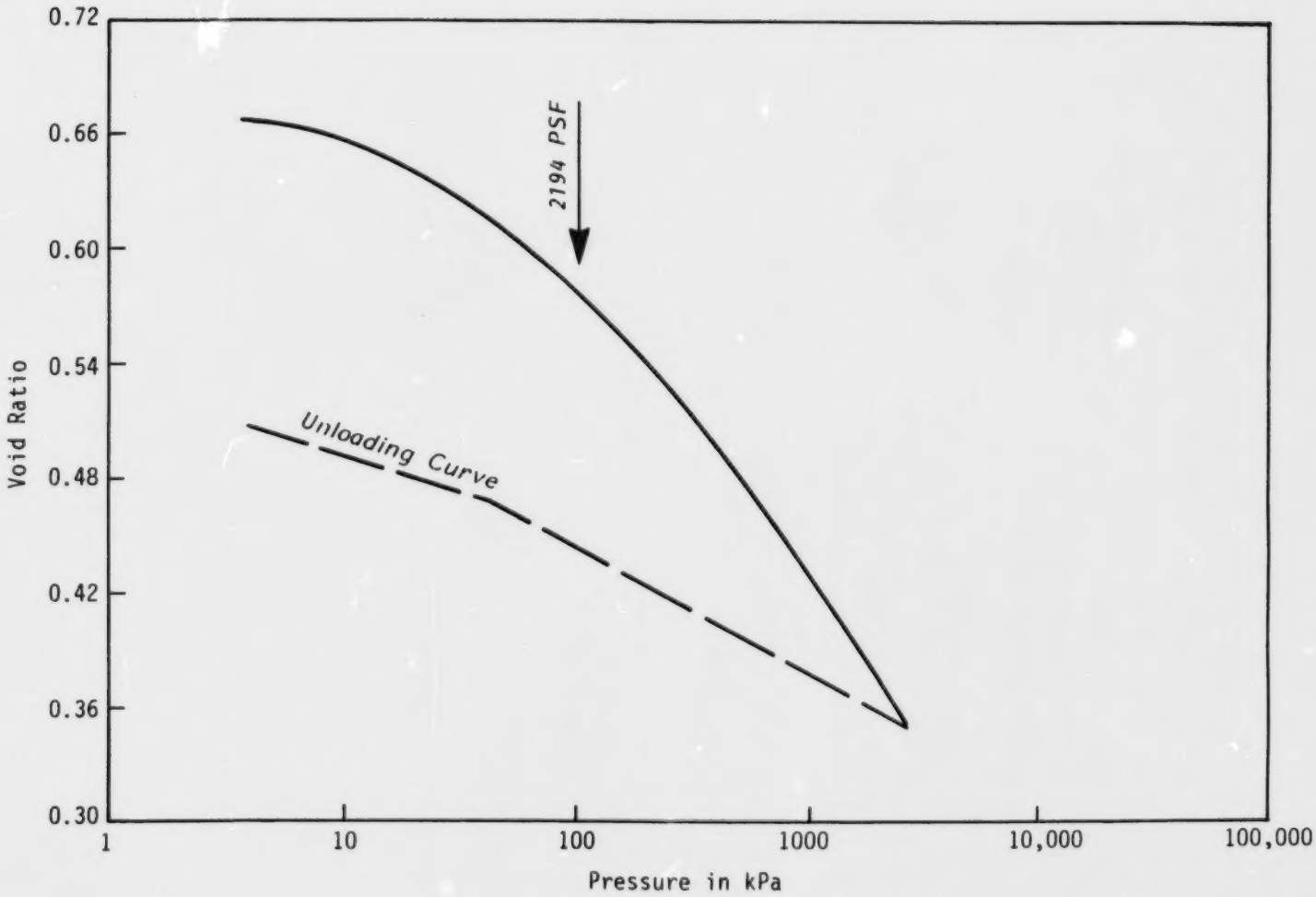


FIGURE 22
DECEW FALLS GS
CONSOLIDATION TEST
(BH.5, S-6, 19')

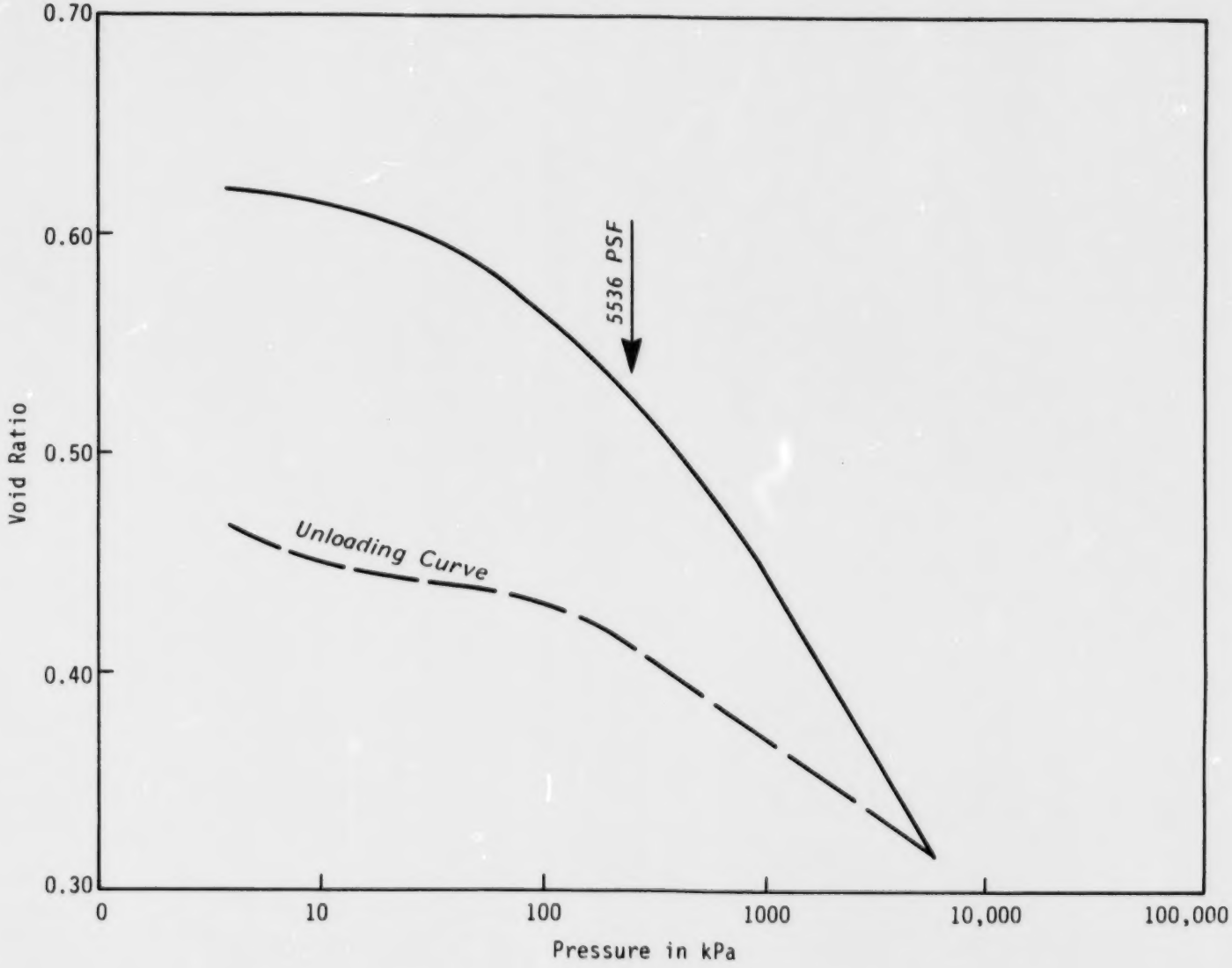


FIGURE 23

DECEW FALLS GS
CONSOLIDATION TEST
(BH.6, S-7, 21')

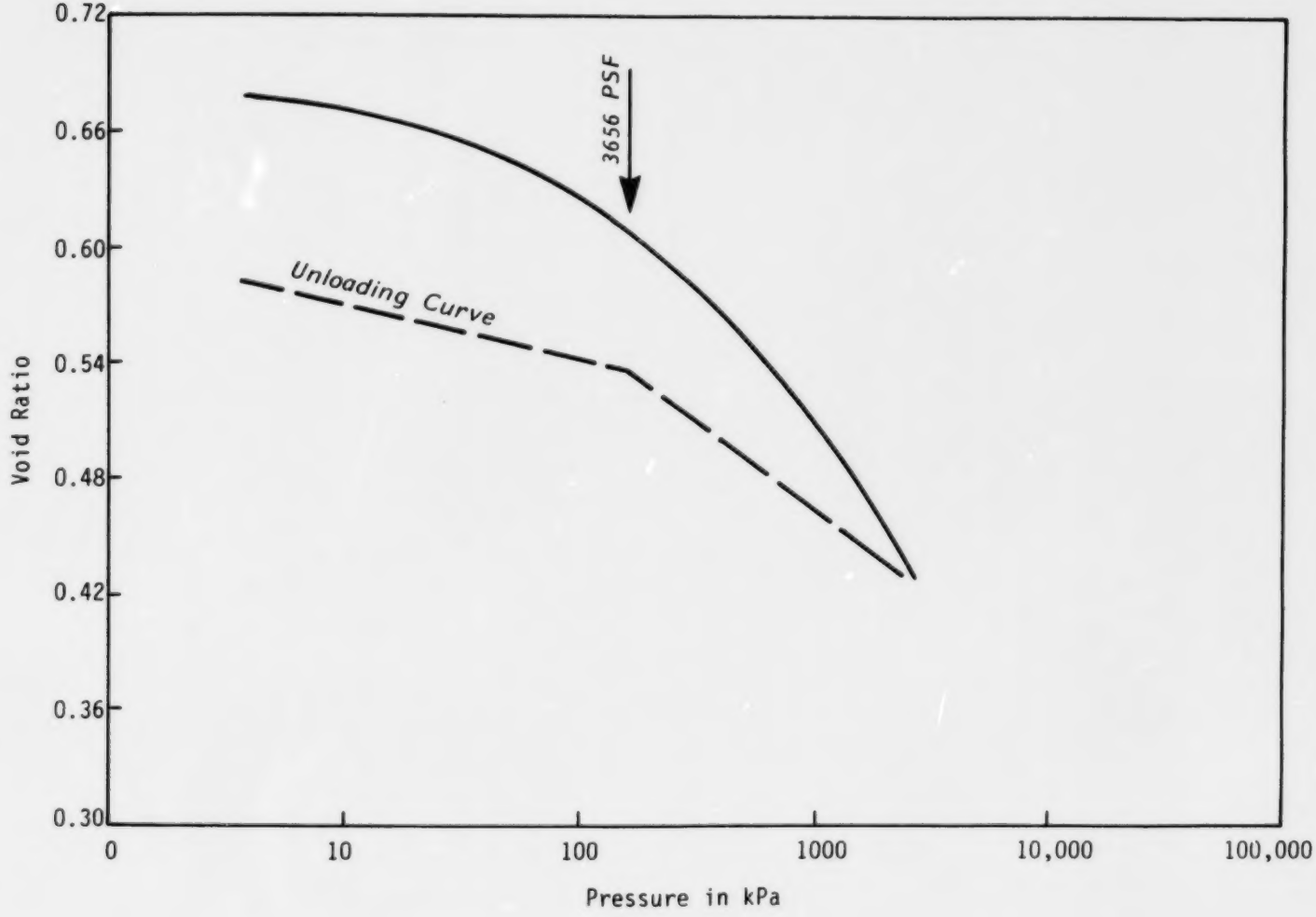


FIGURE 24

DECEW FALLS GS
CONSOLIDATION TEST
(BH.8, S-5, 16')

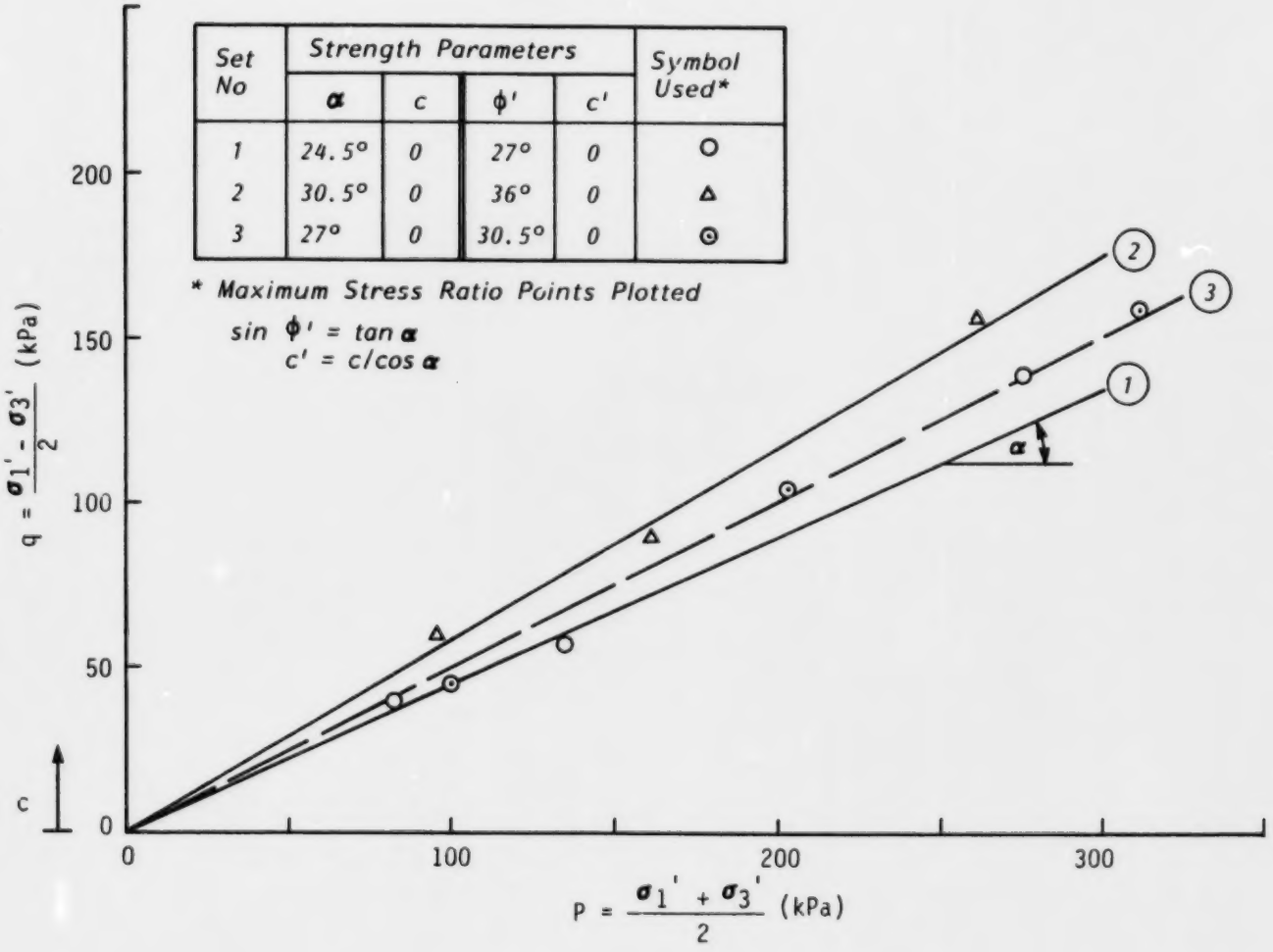


FIGURE 25
DECEW TRIAXIAL TESTS: P-Q METHOD

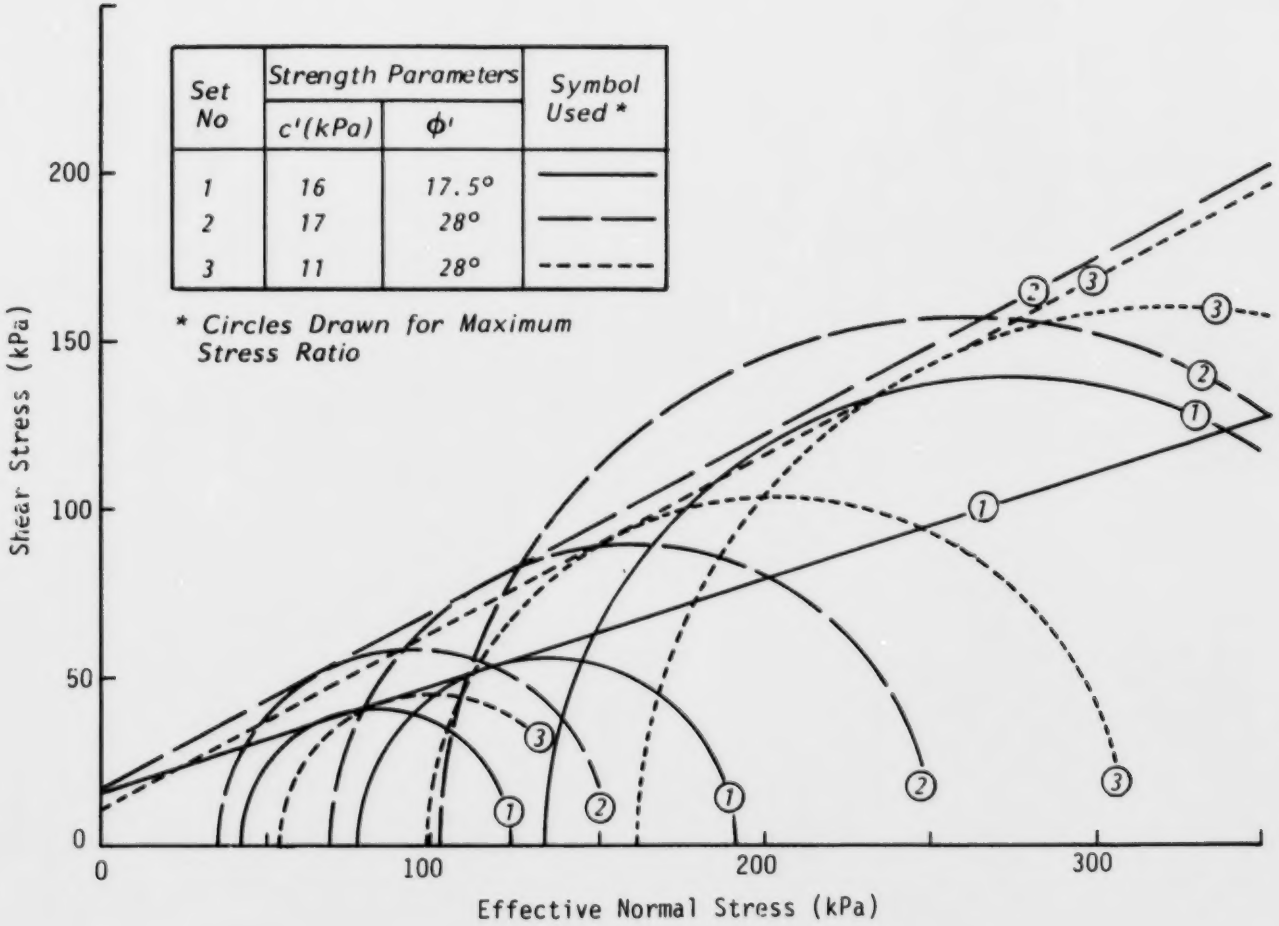


FIGURE 26

DECEW TRIAXIAL TESTS: MOHR CIRCLE METHOD
(EFFECTIVE STRESS)

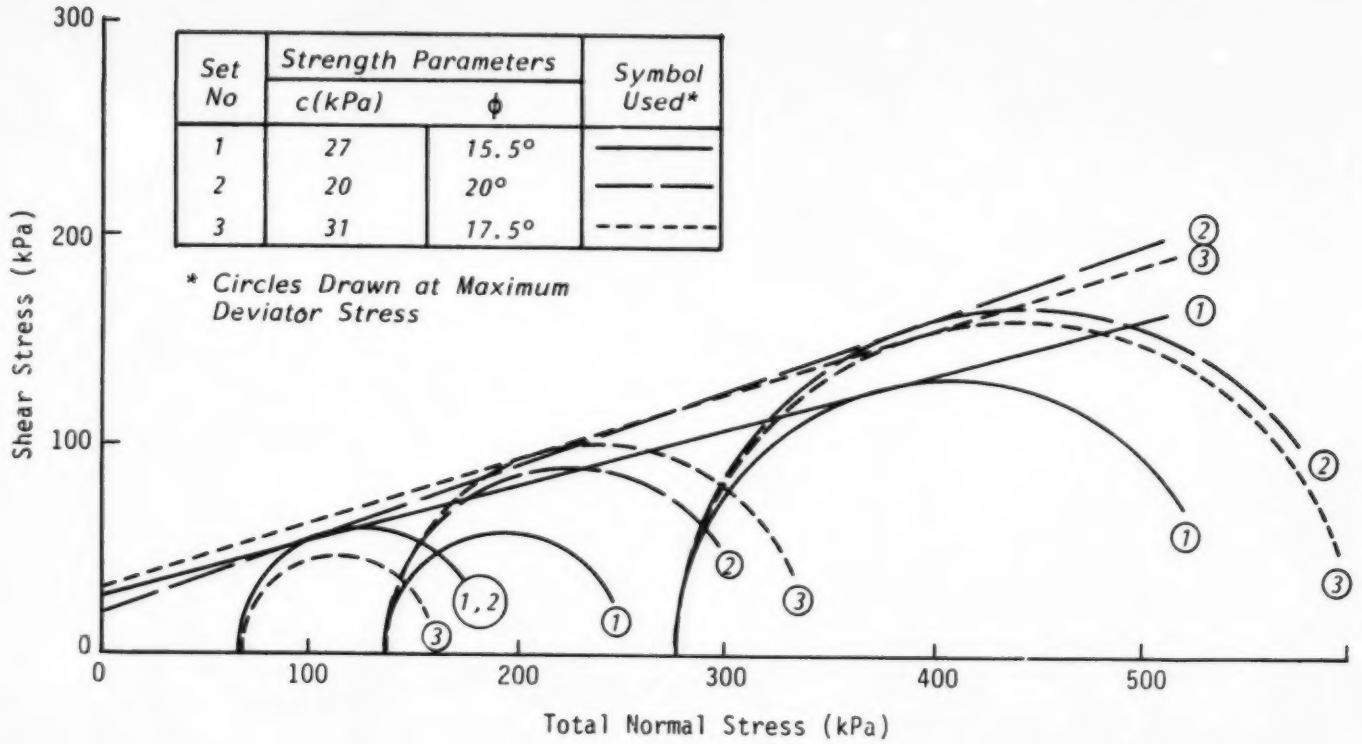


FIGURE 27

DECEW TRIAXIAL TESTS: MOHR CIRCLE METHOD
(TOTAL STRESS)

APPENDIX A

DeCew Falls GS Dykes Permeability Tests

TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST

FIGURES 4-1 and 5-1 to 6-2, inclusive

TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST

SHEET 1 OF 1

FIGURE 4-1

BOREHOLE NUMBER 5 PROJECT 861-1384
SAMPLE NUMBER 9
SAMPLE LOCATION 4.57 - 5.18 m Ontario Hydro / Testing / DeCew Falls
SAMPLE TYPE Grey silty clay to clayey silt (Dilated)

ORIGINAL: LENGTH cm TESTED: AREA cm2 WET WEIGHT gm
DIAMETER cm LENGTH cm DRY WEIGHT gm
AREA cm2 PRESSURE kPA VOLUME WATER cc
VOLUME cc HYDRAULIC GRADIENT (p/l)

WATER CONTENT initial %	31.00	SPECIFIC GRAVITY	LIQUID LIMIT %
WATER CONTENT final %		VOLUME SOLIDS cc	PLASTIC INDEX %
UNIT WEIGHT kN/m3		VOLUME VOIDS cc	CLAY FRACTION (.002mm) %
DRY UNIT WEIGHT kN/m3		VOID RATIO	SILT FRACTION (.06mm) %
lb/ft3		SATURATION %	

SATURATION by BACK PRESSURE (achieved)

Cell Pressure kPa	Back Pressure kPa	Test Duration min	Volume Water cc	B Value

PERMEABILITY TEST CONDITIONS

Cell Pressure kPa	Head Pressure kPa	Back Pressure kPa	Effective Head Pressure kPa	Constant Ah	Effective Confining Pressure Top kPa	Effective Confining Pressure Base kPa
			0.00			

DATE YY-MM-DD	CLOCK time	ELAPSED TIME min.	ELAPSED TIME sec.	INFLOW Vc cc	INFLOW aVc cc	OUTFLOW Vc cc	OUTFLOW aVc cc	DAILY PERMEABILITY RESULTS INFLOW cm/s	DAILY PERMEABILITY RESULTS OUTFLOW cm/s

COEFFICIENT of PERMEABILITY,k, cm/s

TOTAL FLOW
MINUTES INFLOW,k
OUTFLOW,k
AVERAGE,k

NOTES
Sample poured out of shelby tube, non-testable

PART 1
MINUTES INFLOW,k cm/s
OUTFLOW,k cm/s
AVERAGE,k cm/s

PART 2
MINUTES INFLOW,k cm/s
OUTFLOW,k cm/s
AVERAGE,k cm/s

AVERAGE,k USE FOR ANALYSES cm/s

Data by F.A.R.

Golder Associates

TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST

SHEET 1 OF 2

FIGURE 5-1

BOREHOLE NUMBER 5 PROJECT 861-1384
SAMPLE NUMBER 6
SAMPLE LOCATION 5.49 - 6.10 m Ontario Hydro / Testing / DeCew Falls
SAMPLE TYPE Grey silty clay non-fibrous organics trace fine sand

ORIGINAL:	LENGTH cm	6.320	TESTED:	AREA cm2	18.17	WET WEIGHT gm	234.1
	DIAMETER cm	4.810		LENGTH cm	6.32	DRY WEIGHT gm	190.8
	AREA cm2	18.173		PRESSURE kPA	30.32	VOLUME WATER cc	43.3
	VOLUME cc	114.856	HYDRAULIC GRADIENT (p/l)		113.46		

WATER CONTENT initial %	22.70	SPECIFIC GRAVITY	2.700	LIQUID LIMIT %	
WATER CONTENT final %	23.90	VOLUME SOLIDS cc	70.667	PLASTIC INDEX %	
UNIT WEIGHT kN/m3	19.98	VOLUME VOIDS cc	44.189	CLAY FRACTION (.002mm) %	
DRY UNIT WEIGHT kN/m3	16.29	VOID RATIO	0.625	SILT FRACTION (.06mm) %	
lb/ft3	103.67	SATURATION %	98.078		

SATURATION by BACK PRESSURE (achieved)

Cell Pressure kPa	Back Pressure kPa	Test Duration min	Volume Water cc	B Value
306.6	299.7	2659	1.6	0.97

PERMEABILITY TEST CONDITIONS

Cell Pressure kPa	Head Pressure kPa	Back Pressure kPa	Effective Head Pressure kPa	Constant Ah	Effective Confining Pressure Top kPa	Effective Confining Pressure Base kPa
400.3	370.0	299.7	70.28	13028.73	30.3	100.6

DATE YY-MM-DD	CLOCK time	ELAPSED TIME min.	ELAPSED TIME sec.	INFLOW Vc cc	INFLOW aVc cc	OUTFLOW Vc cc	OUTFLOW aVc cc	DAILY PERMEABILITY RESULTS INFLOW cm/s	DAILY PERMEABILITY RESULTS OUTFLOW cm/s
86-11-30	13:25	0	0	51.00	0.0	62.90	0.0		
86-12-01	08:36	1151	69060	53.00	1.20	60.70	2.20	8.43E-09	1.54E-08
86-12-02	08:49	2604	156240	55.70	3.90	57.90	5.00	1.50E-08	1.56E-08
86-12-03	08:43	4038	242280	58.30	6.50	55.20	7.70	1.47E-08	1.52E-08
86-12-04	09:33	5528	331680	61.00	9.20	52.30	10.60	1.46E-08	1.57E-08

COEFFICIENT of PERMEABILITY,k, cm/s

TOTAL FLOW

MINUTES		
5528	INFLOW,k	1.32E-08
	OUTFLOW,k	1.55E-08
	AVERAGE,k	1.43E-08

PART 1

MINUTES			
4377	INFLOW,k	1.48E-08	cm/s
	OUTFLOW,k	1.55E-08	cm/s
	AVERAGE,k	1.51E-08	cm/s

PART 2

MINUTES			
4377	INFLOW,k	1.48E-08	cm/s
	OUTFLOW,k	1.55E-08	cm/s
	AVERAGE,k	1.51E-08	cm/s
AVERAGE,k USE FOR ANALYSES		1.51E-08	cm/s

NOTES

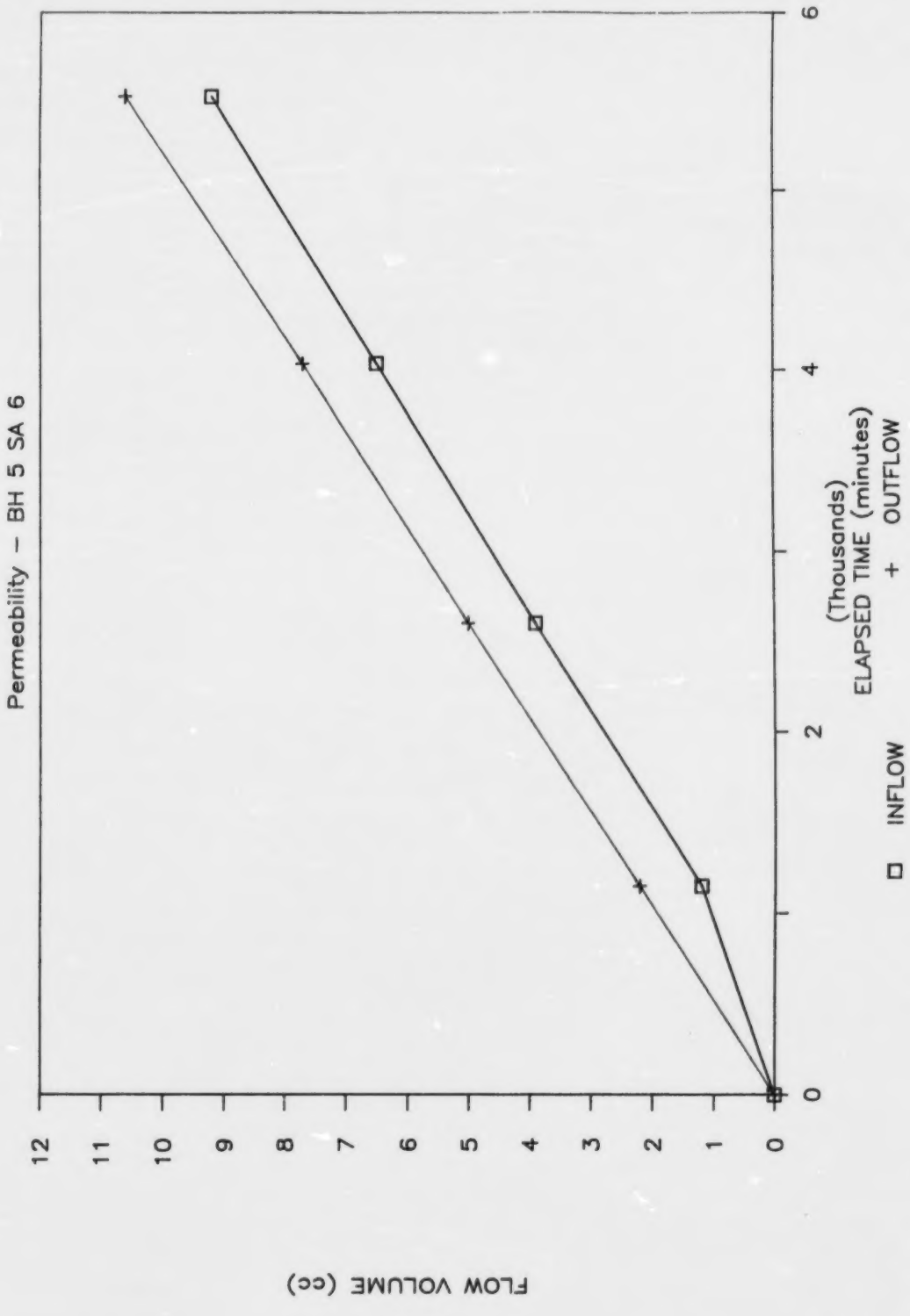
Membrane sealed onto sample with vacuum grease,
0 time after 1440 minutes of permeability run.

Data by F.A.R.

Golder Associates

TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST
SHEET 2 OF 2

FIGURE 5-2



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88-6

TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST

SHEET 1 OF 2

FIGURE 6-1

BOREHOLE NUMBER 8 PROJECT 861-1384
SAMPLE NUMBER 7
SAMPLE LOCATION 6.86 m Ontario Hydro / Testing / DeCew Falls
SAMPLE TYPE Red Brown silty clay to clayey silt

ORIGINAL:	LENGTH cm	6.720	TESTED:	AREA cm2	17.43	WET WEIGHT gm	243.7
	DIAMETER cm	4.710		LENGTH cm	6.72	DRY WEIGHT gm	197.3
	AREA cm2	17.426		PRESSURE kPA	30.32	VOLUME WATER cc	46.4
	VOLUME cc	117.100	HYDRAULIC GRADIENT (p/l)		106.70		

WATER CONTENT initial %	23.50	SPECIFIC GRAVITY	2.700	LIQUID LIMIT %	
WATER CONTENT final %	25.60	VOLUME SOLIDS cc	73.074	PLASTIC INDEX %	
UNIT WEIGHT kN/m3	20.40	VOLUME VOIDS cc	44.026	CLAY FRACTION (.002mm) %	
DRY UNIT WEIGHT kN/m3	16.52	VOID RATIO	0.602	SILT FRACTION (.06mm) %	
lb/ft3	105.16	SATURATION %	105.438		

SATURATION by BACK PRESSURE (achieved)

Cell Pressure kPa	Back Pressure kPa	Test Duration min	Volume Water cc	B Value
386.6	299.7	2637	2.9	0.97

PERMEABILITY TEST CONDITIONS

Cell Pressure kPa	Head Pressure kPa	Back Pressure kPa	Effective Head Pressure kPa	Constant Ah	Effective Confining Pressure Top kPa	Effective Confining Pressure Base kPa
400.3	370.0	299.7	70.28	12498.11	30.3	100.6

DATE YY-MM-DD	CLOCK time	ELAPSED TIME min.	ELAPSED TIME sec.	INFLOW Vc cc	INFLOW aVc cc	OUTFLOW Vc cc	OUTFLOW aVc cc	DAILY PERMEABILITY RESULTS INFLOW cm/s	DAILY PERMEABILITY RESULTS OUTFLOW cm/s
86-11-30	13:25	0	0	17.00	0.0	38.20	0.0		
86-12-01	08:37	1152	69120	16.70	0.30	37.90	0.30	2.33E-09	2.33E-09
86-12-02	08:58	2613	156780	12.70	4.30	34.40	3.80	2.45E-08	2.15E-08
86-12-03	08:43	4038	242280	8.10	8.90	29.70	8.50	2.89E-08	2.96E-08
86-12-04	09:33	5528	331680	4.80	12.20	24.90	13.30	1.98E-08	2.89E-08

COEFFICIENT of PERMEABILITY,k, cm/s

TOTAL FLOW

MINUTES		
5528	INFLOW,k	1.89E-08
	OUTFLOW,k	2.06E-08
	AVERAGE,k	1.97E-08

NOTES

Membrane sealed onto sample with vacuum grease,
0 time after 1440 minutes of permeability run.

Data by F.A.R.

PART 1

MINUTES			
4376	INFLOW,k	2.44E-08	cm/s
	OUTFLOW,k	2.66E-08	cm/s
	AVERAGE,k	2.55E-08	cm/s

PART 2

MINUTES			
4376	INFLOW,k	2.44E-08	cm/s
	OUTFLOW,k	2.66E-08	cm/s
	AVERAGE,k	2.55E-08	cm/s
AVERAGE,k USE FOR ANALYSES		2.55E-08	cm/s

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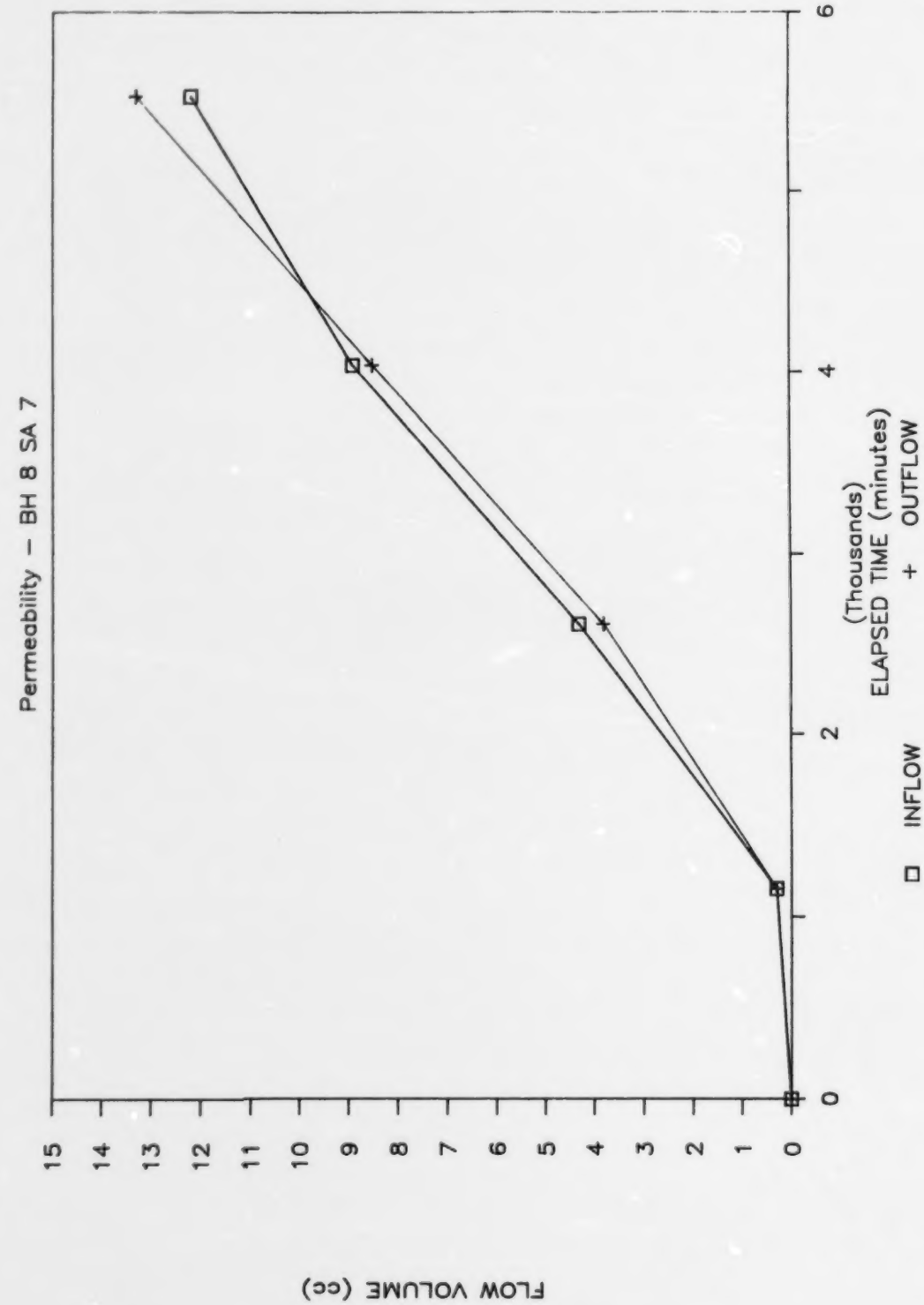
TRIAXIAL PERMEABILITY (CONSTANT HEAD) TEST

SHEET 2 OF 2

FIGURE 6-2



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APPENDIX B

DeCew Falls GS Dykes Triaxial Strength Tests

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

FIGURES 1-1 to 3-3, inclusive

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 1 OF 3

FIGURE 1-1

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

	A	B	C
BOREHOLE NUMBER	3	3	3
SAMPLE NUMBER	5	6	5
SAMPLE DEPTH , m	4.73	5.64	5.03
SPECIMEN DIAMETER , cm	4.77	4.78	4.78
SPECIMEN HEIGHT , cm	10.11	10.06	10.08
WATER CONTENT BEFORE CONSOLIDATION %	28.2	26.3	26.9
CELL PRESSURE, kPa	337.6	406.5	544.3
BACK PRESSURE, kPa	268.7	268.7	268.7
PORE PRESSURE PARAMETER, B	0.98	0.98	0.98
CONSOLIDATION PRESSURE,Sc, kPa	68.9	137.8	275.6
VOLUME CHANGE CONSOLIDATION,Vc,cc	-4.2	-9.1	-12.4
WATER CONTENT AFTER CONSOLIDATION %	26.8	23.2	22.8
AVERAGE RATE OF STRAIN,%/hr	0.5	0.5	0.5
AVERAGE LOAD INCREMENT, kPa			
AVERAGE LOAD DURATION ,hr			
TIME TO FAILURE ,days	1.5	1.5	1.5
WATER CONTENT AFTER TEST %	24.0	23.7	20.8
MAX.DEVIATOR STRESS,(S1-S3),kPa	114.5	112.4	264.3
AXIAL STRAIN AT FAILURE,(S1-S3)max.%	8.1	7.8	5.4
MAX EFFECTIVE PRINCIPAL STRESS RATIO ,(S'1/S'3)max.%	2.68	2.44	3.10
AXIAL STRAIN AT (S'1/S'3)max.	8.1	7.8	5.4
PORE PRESSURE PARAMETER,Af	0.006	0.533	0.566
NATURAL WATER CONTENT ,w,%	25.1	23.5	23.7
LIQUID LIMIT, wl			
PLASTIC LIMIT, wp			
DRY UNIT WEIGHT, kn/m	16.20	16.04	16.22
FILTER DRAINS USED ,y/n	Y	y	y
SAMPLE DESCRIPTION	A, Brown silty clay with some sandy silt inclusions		
	B, Brown silty clay,silty sand inclusions, non-fibrous oganic layer		
	C, same as sample A		
RATE OF STRAIN,%/hr.CHANGED	n/a	n/a	n/a
AXIAL STRAIN,%,WHERE CHANGED	n/a	n/a	n/a
FAILURE PLANE NUMBER	n/a	n/a	n/a
ANGLE OF FAILURE, DEGREES	bulging	bulging	bulging
LAB. VANE PEAK STRENGTH (kPa)			
LAB.VANE RESIDUAL STRENGTH (kPa)			
DATE	December,1986		
PROJECT NUMBER	861-1384 (DeCew Falls Hydroelectric Project)		
DATA BY	F.A.R.		

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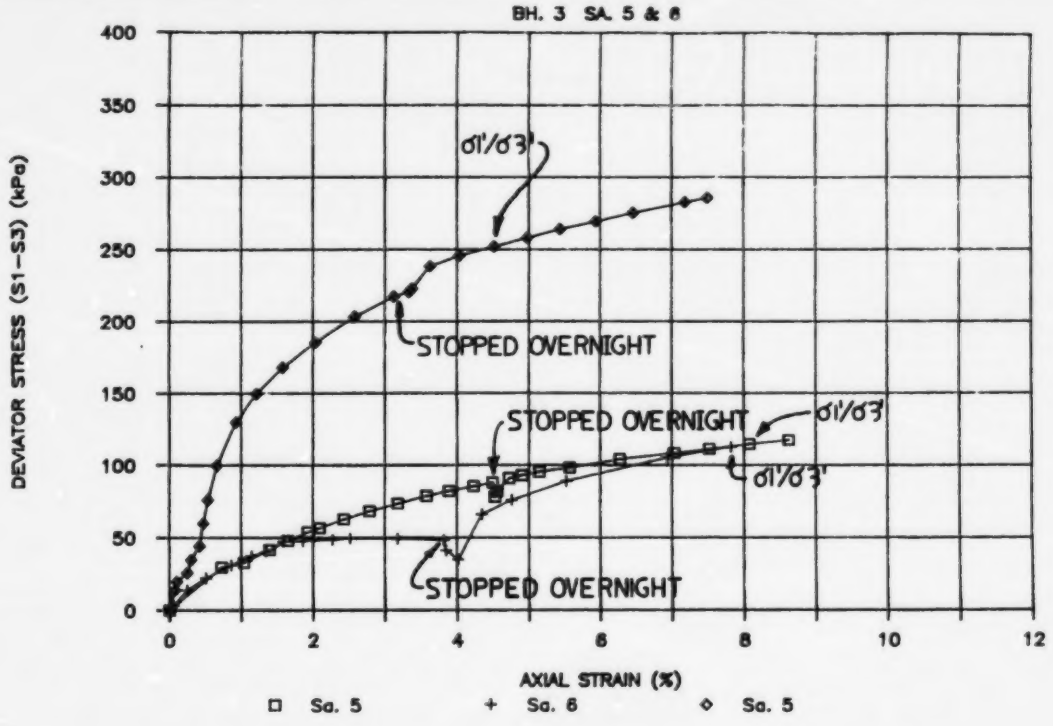
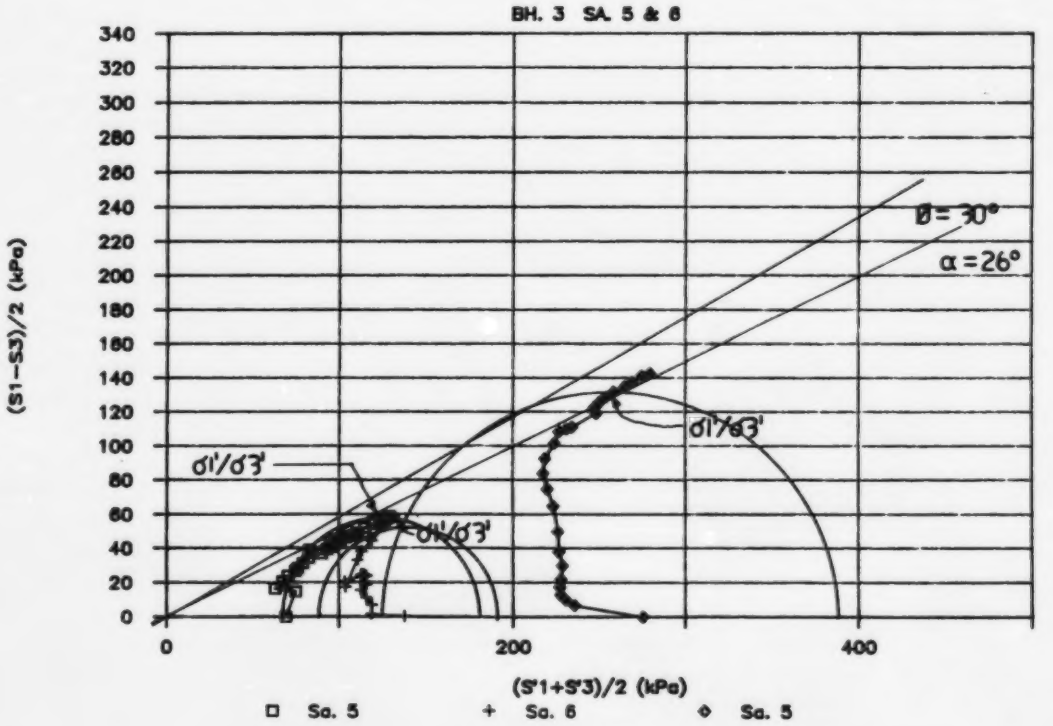
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 2 OF 3

FIGURE 1-2





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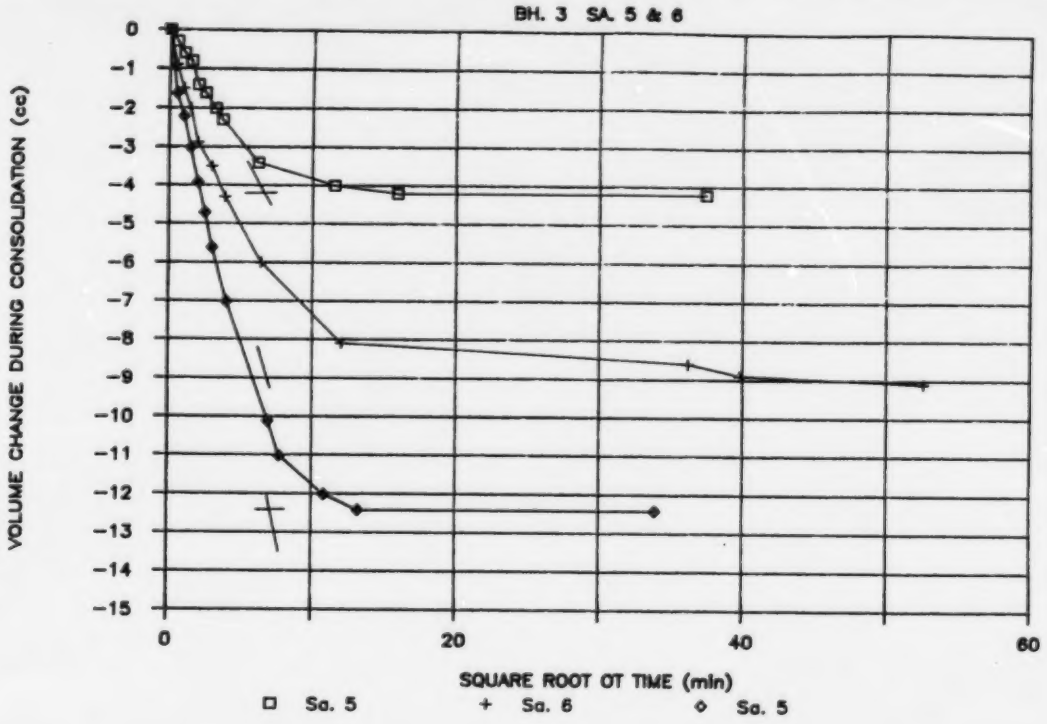
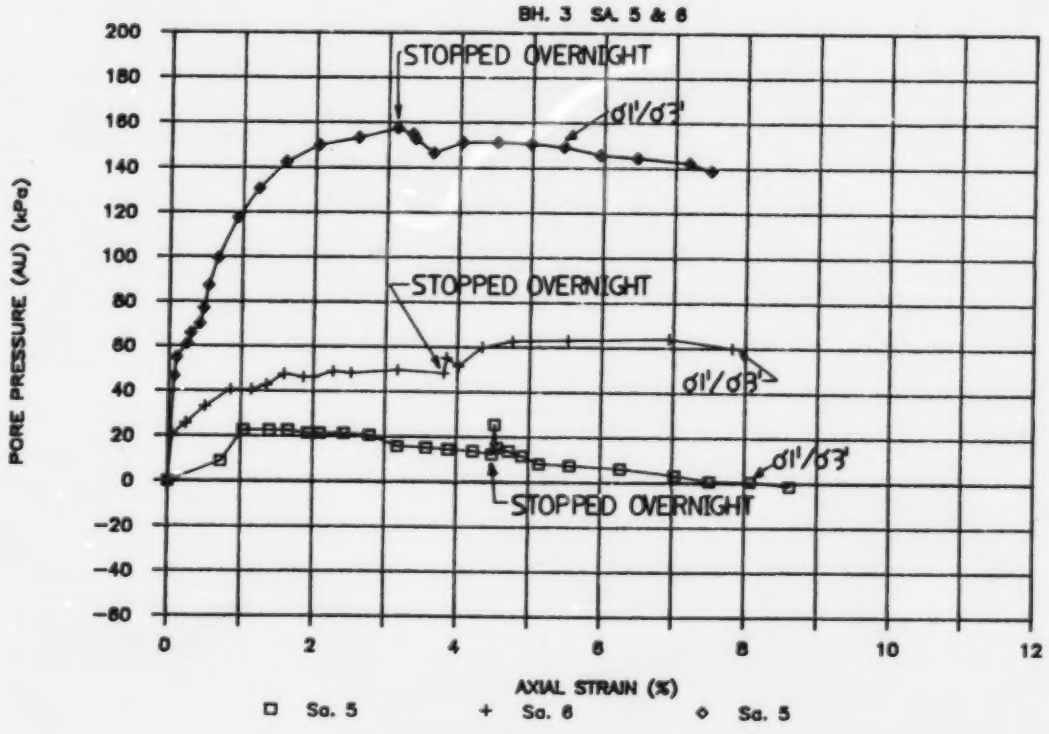
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 3 OF 3

FIGURE 1-3





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CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 1 OF 3

FIGURE 2-1

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

Multi-Stage Test	A	B	C
BOREHOLE NUMBER	4	4	4
SAMPLE NUMBER	7	7	7
SAMPLE DEPTH , m	6.55	6.55	6.55
SPECIMEN DIAMETER , cm	3.74	3.77	3.80
SPECIMEN HEIGHT , cm	7.47	7.02	6.76
WATER CONTENT BEFORE CONSOLIDATION %	34.3	31.1	29.7
CELL PRESSURE, kPa	337.6	406.5	544.3
BACK PRESSURE, kPa	268.7	268.7	268.7
PORE PRESSURE PARAMETER, B	0.98	0.98	0.98
CONSOLIDATION PRESSURE,Sc, kPa	68.9	137.8	275.6
VOLUME CHANGE CONSOLIDATION,Vc,cc	-3.8	-1.7	-1.4
WATER CONTENT AFTER CONSOLIDATION %	31.1	29.7	28.5
AVERAGE RATE OF STRAIN,%/hr	0.5	0.5	0.5
AVERAGE LOAD INCREMENT, kPa			
AVERAGE LOAD DURATION ,hr			
TIME TO FAILURE ,days	1	1	1
WATER CONTENT AFTER TEST %	31.1	29.7	28.0
MAX.DEVIATOR STRESS,(S1-S3),kPa	118.5	178.4	333.6
AXIAL STRAIN AT FAILURE,(S1-S3)max.%	4.2	3.0	5.3
MAX EFFECTIVE PRINCIPAL STRESS RATIO ,(S'1/S'3)max.%	4.37	3.49	3.80
AXIAL STRAIN AT (S'1/S'3)max.	4.2	3.0	5.3
PORE PRESSURE PARAMETER,Af	0.285	0.371	0.469
NATURAL WATER CONTENT ,w,%	31.4	31.1	29.7
LIQUID LIMIT, wl			
PLASTIC LIMIT, wp			
DRY UNIT WEIGHT, kn/m	14.31	15.02	15.35
FILTER DRAINS USED ,y/n	Y	y	y
SAMPLE DESCRIPTION	A,Grey Black non-fibrous organic clayey silt to silty clay B,same as sample A C,same as sample A		
RATE OF STRAIN,%/hr.CHANGED	n/a	n/a	n/a
AXIAL STRAIN,%,WHERE CHANGED	n/a	n/a	n/a
FAILURE PLANE NUMBER	n/a	n/a	n/a
ANGLE OF FAILURE, DEGREES			bulging
LAB. VANE PEAK STRENGTH (kPa)			
LAB.VANE RESIDUAL STRENGTH (kPa)			
DATE	December,1986		
PROJECT NUMBER	861-1384 (DeCew Falls Hydroelectric Project)		
DATA BY	F.A.R.		

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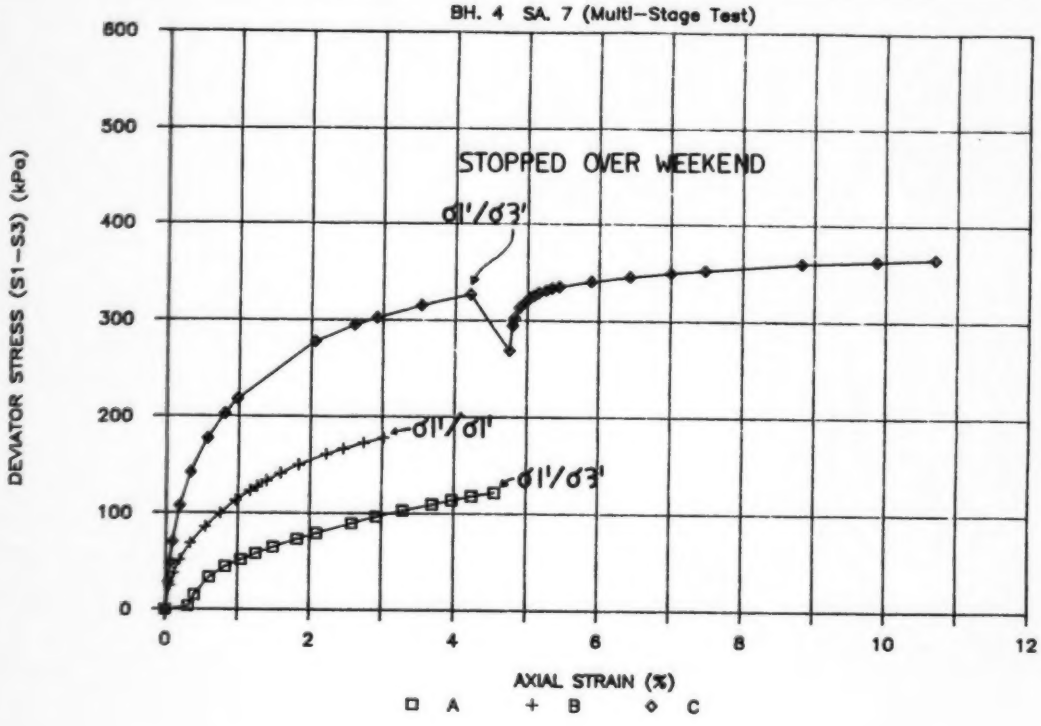
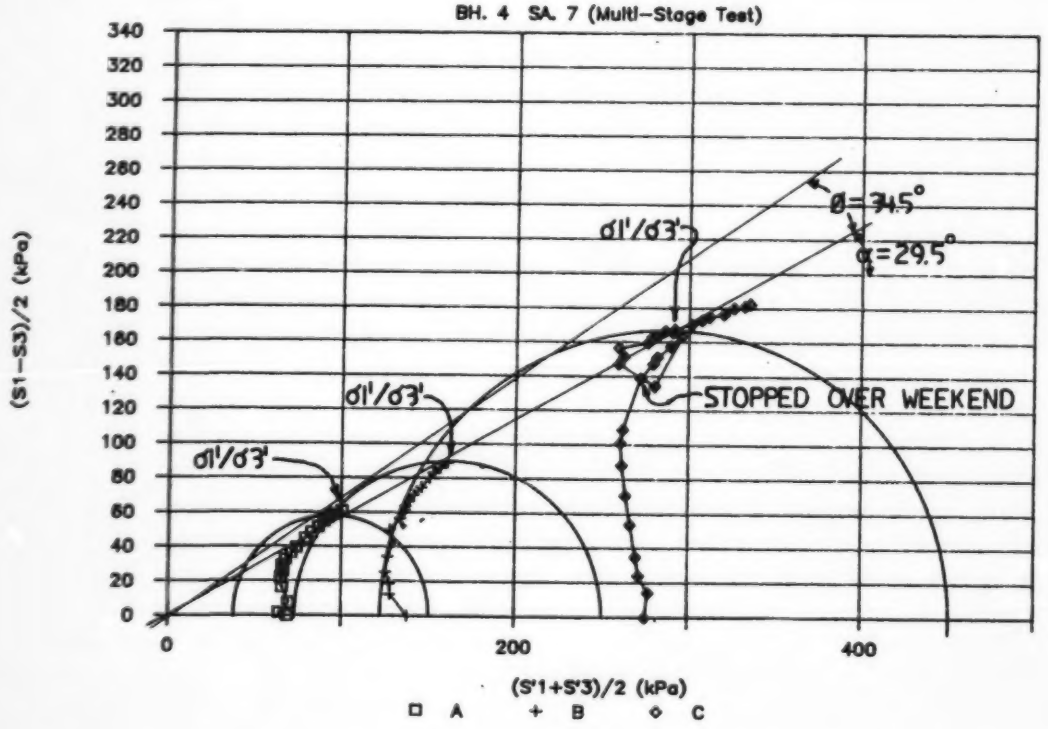
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 2 OF 3

FIGURE 2-2





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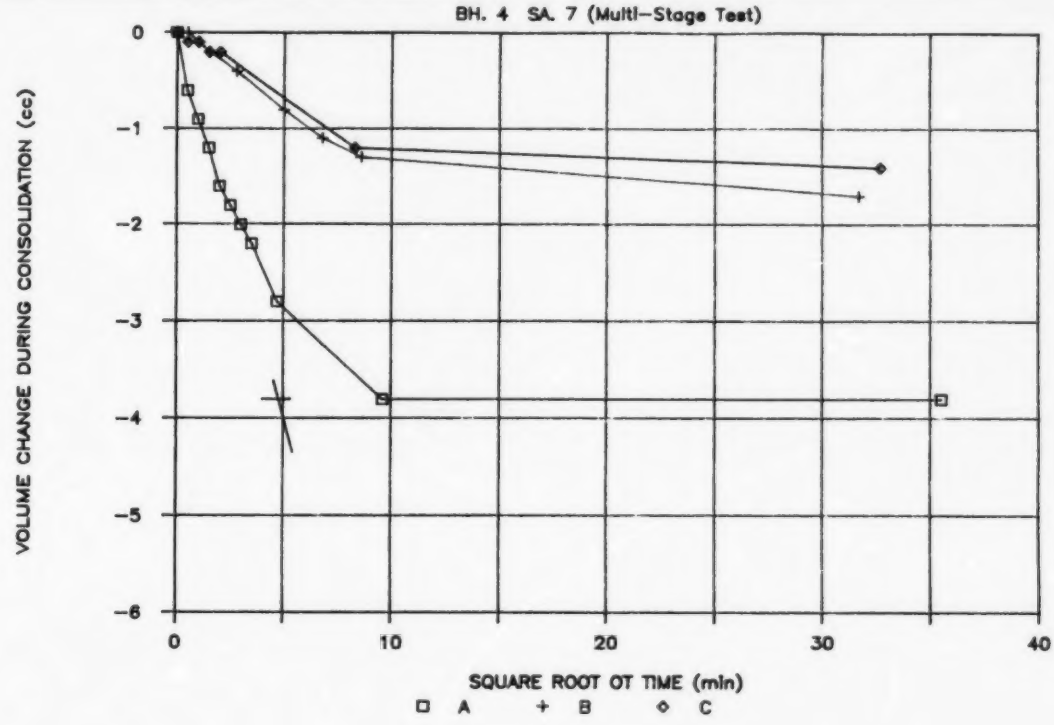
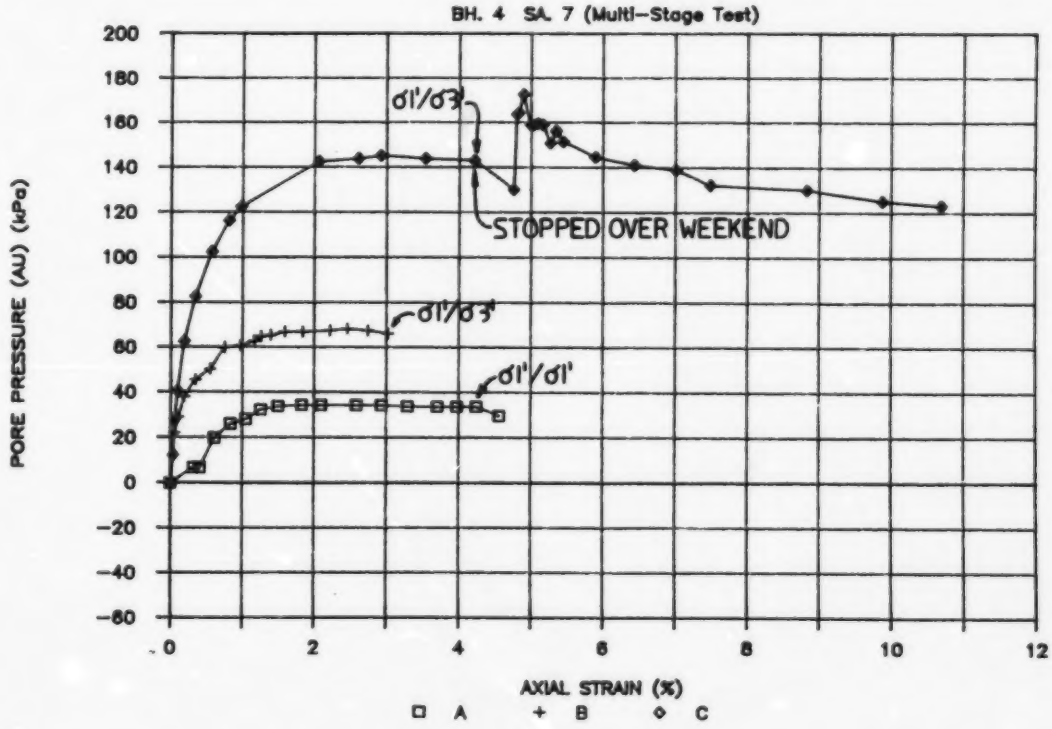
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 3 OF 3

FIGURE 2-3





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CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS
SHEET 1 OF 3

FIGURE 3-1

CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

	A	B	C
BOREHOLE NUMBER	8	8	8
SAMPLE NUMBER	8	8	9
SAMPLE DEPTH , m	7.47	7.62	8.08
SPECIMEN DIAMETER , cm	4.75	4.73	4.77
SPECIMEN HEIGHT , cm	10.16	9.90	10.12
WATER CONTENT BEFORE CONSOLIDATION %	25.3	22.4	23.5
CELL PRESSURE, kPa	337.6	406.5	544.3
BACK PRESSURE, kPa	268.7	268.7	268.7
PORE PRESSURE PARAMETER, B	0.99	0.99	0.99
CONSOLIDATION PRESSURE,Sc, kPa	68.9	137.8	275.6
VOLUME CHANGE CONSOLIDATION,Vc,cc	-3.8	-8.7	-11.7
WATER CONTENT AFTER CONSOLIDATION %	24.0	19.5	19.7
AVERAGE RATE OF STRAIN,%/hr	0.5	0.5	0.5
AVERAGE LOAD INCREMENT, kPa			
AVERAGE LOAD DURATION ,hr			
TIME TO FAILURE ,days	1.5	1.5	1.5
WATER CONTENT AFTER TEST %	23.7	20.5	21.7
MAX.DEVIATOR STRESS,(S1-S3),kPa	90.2	201.7	323.1
AXIAL STRAIN AT FAILURE,(S1-S3)max.%	4.4	5.5	4.6
MAX EFFECTIVE PRINCIPAL STRESS RATIO ,(S'1/S'3)max.%	2.62	3.17	3.00
AXIAL STRAIN AT (S'1/S'3)max.	4.4	5.5	4.6
PORE PRESSURE PARAMETER,Af	0.145	0.222	0.352
NATURAL WATER CONTENT ,w,%	23.8	20.1	21.2
LIQUID LIMIT, wl			
PLASTIC LIMIT, wp			
DRY UNIT WEIGHT, kn/m3	16.36	16.92	16.57
FILTER DRAINS USED ,y/n	Y	y	y
SAMPLE DESCRIPTION	A, Brown silty clay with some sandy silt inclusions		
	B, Brown clayey silt to silty clay with fine gravel		
	C, same as sample B		
RATE OF STRAIN,%/hr.CHANGED	n/a	n/a	n/a
AXIAL STRAIN,%,WHERE CHANGED	n/a	n/a	n/a
FAILURE PLANE NUMBER	n/a	n/a	n/a
ANGLE OF FAILURE, DEGREES	bulging	bulging	bulging
LAB. VANE PEAK STRENGTH (kPa)			
LAB.VANE RESIDUAL STRENGTH (kPa)			
DATE	December,1986		
PROJECT NUMBER	861-1384 (DeCew Falls Hydroelectric Project)		
DATA BY	F.A.R.		

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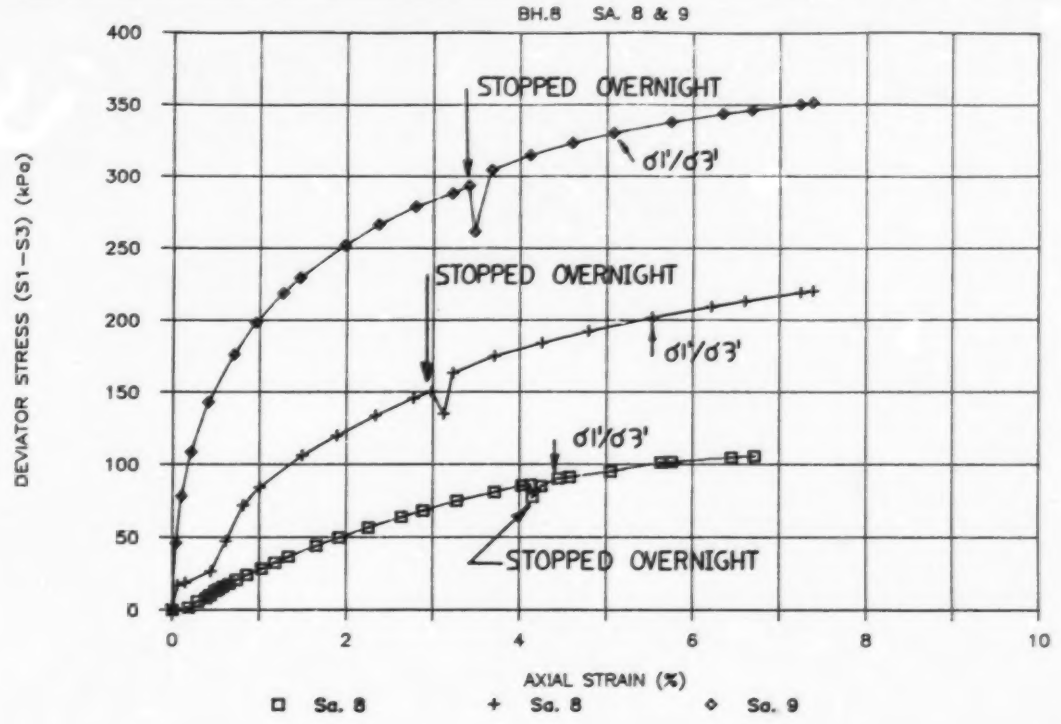
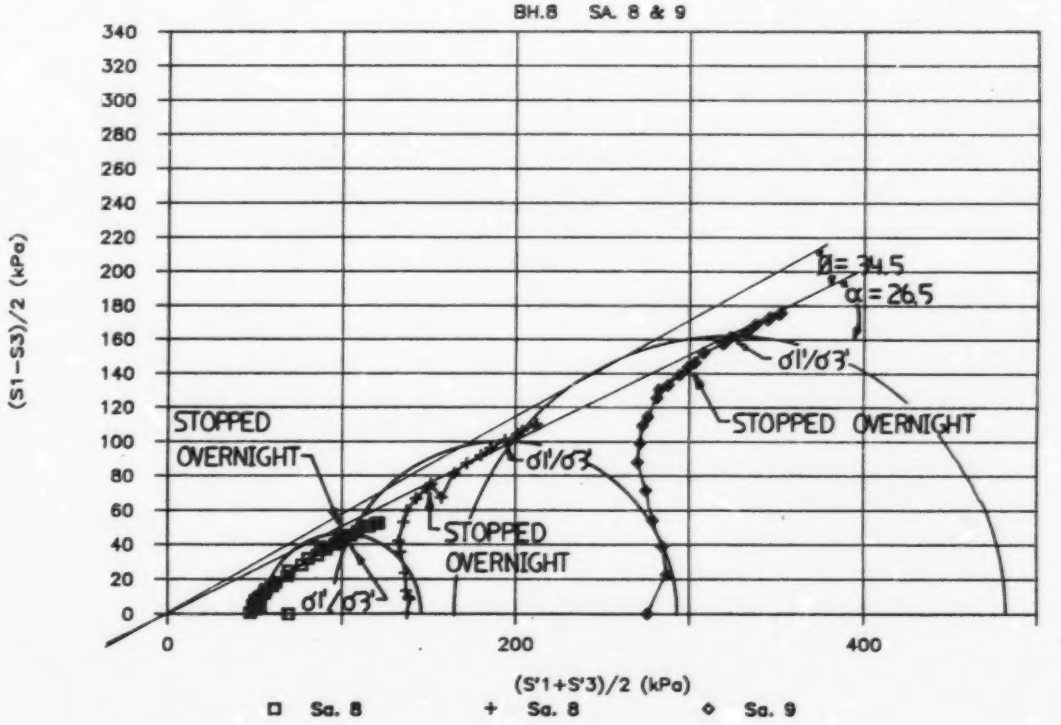
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 2 OF 3

FIGURE 3-2





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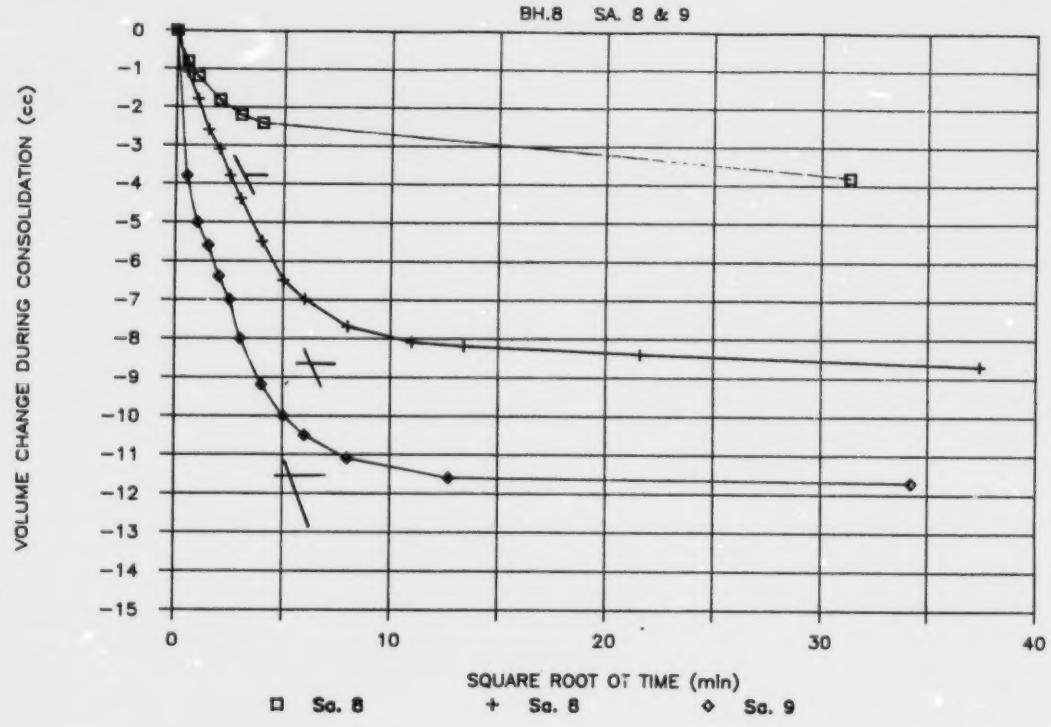
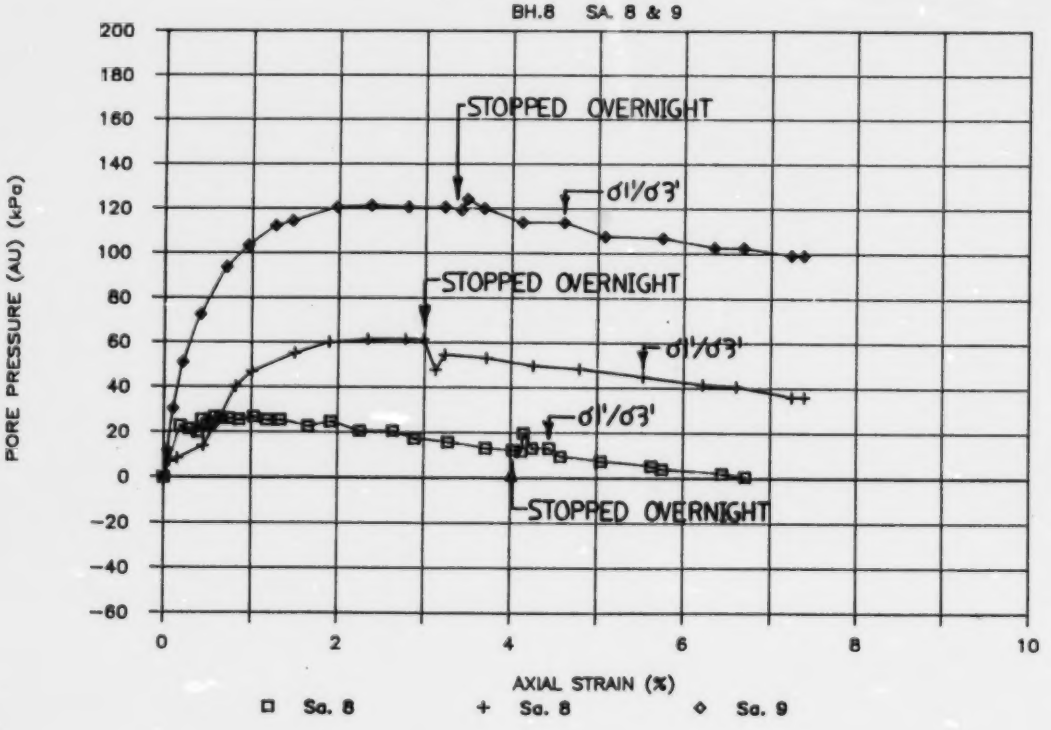
CONSOLIDATED UNDRAINED TRIAXIAL
WITH PORE PRESSURE MEASUREMENTS

SHEET 3 OF 3

FIGURE 3-3





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CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

WORK SHEETS

CYCLE A

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384
Sample Number: BH 3 SA 5 & 6

Sample A: Sa. 5
Sample B: Sa. 6
Sample C: Sa. 5

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	337.6	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	68.9
0.5	-0.3		277.7	9.0	72.0	0.72	20.0	29.44	1.49	14.7	74.7
1.0	-0.6		291.4	22.7	103.0	1.03	22.3	32.72	1.71	16.4	62.5
1.5	-0.8		291.4	22.7	139.0	1.39	28.5	41.67	1.90	20.8	67.0
2.0	-1.4		291.4	22.7	165.0	1.64	32.9	47.97	2.04	24.0	70.1
2.5	-1.6		290.1	21.4	192.6	1.92	37.0	53.80	2.13	26.9	74.4
3.2	-2.0		290.1	21.4	209.1	2.08	39.0	56.62	2.19	28.3	75.8
3.7	-2.3		290.1	21.4	243.2	2.42	43.4	62.78	2.32	31.4	78.9
6.2	-3.4		289.4	20.7	279.1	2.78	47.4	68.32	2.42	34.2	82.4
11.5	-4.0		284.6	15.8	318.3	3.17	51.3	73.64	2.39	36.8	89.9
15.9	-4.2		283.9	15.2	358.4	3.57	55.1	78.77	2.47	39.4	93.1
37.4	-4.2		283.2	14.5	389.0	3.88	57.7	82.23	2.51	41.1	95.5
			282.5	13.8	423.2	4.22	60.1	85.34	2.55	42.7	97.8
LENGTH,INITIAL,cm		10.110	281.1	12.4	450.0	4.49	62.1	87.94	2.56	44.0	100.5
DIAMETER,cm		4.770	294.2	25.5	453.0	4.52	55.2	78.14	[illegible]	39.1	82.5
AREA,INITIAL,cm2		17.872	283.9	15.2	456.0	4.55	58.0	82.08	2.53	41.0	94.8
VOLUME,INITIAL,cc		180.698	282.5	13.8	473.1	4.72	64.3	90.83	2.65	45.4	100.5
CONS. VOLUME CHANGE,		4.2	280.4	11.7	491.1	4.90	66.0	93.06	2.63	46.5	103.7
VOLUMETERIC STRN,cc		0.023	277.0	8.3	515.0	5.13	67.7	95.22	2.57	47.6	108.2
LENGTH,CONS.cm		10.032	276.3	7.6	558.0	5.56	70.2	98.29	2.60	49.1	110.5
AREA,CONS.,cm2		17.595	274.9	6.2	628.0	6.26	74.9	104.09	2.66	52.0	114.7
CONS.VOLUME,cc		176.498	272.1	3.4	704.0	7.03	78.7	108.48	2.66	54.2	119.7
PROVING RING kg/div		0.266	269.4	0.7	753.2	7.51	81.0	111.07	2.63	55.5	123.7
EFF.CELL PRESS.kPa		68.9	269.4	0.7	809.0	8.06	84.0	114.49	2.68	57.2	125.5
			267.3	-1.4	864.0	8.61	86.6	117.33	2.67	58.7	128.9

stopped overnight at 4.49%
morning restarted at 4.52%

CYCLE B

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384

Sample Number: BH 3 SA 5 & 6

Sample A: Sa. 5

Sample B: Sa. 6

Sample C: Sa. 5

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Effective Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	486.5	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	137.8
0.5	-0.9		289.4	20.7	5.5	0.06	1.9	2.86	1.02	1.4	118.6
1.0	-1.5		294.2	25.5	23.8	0.24	9.1	13.65	1.12	6.8	119.1
1.5	-2.0		301.8	33.1	50.0	0.51	14.8	22.15	1.21	11.1	115.0
2.0	-2.9		309.4	40.7	84.5	0.85	20.7	30.87	1.32	15.4	112.6
3.0	-3.5		309.4	40.7	112.7	1.14	25.1	37.32	1.38	18.7	115.0
3.9	-4.3		311.4	42.7	133.0	1.34	27.1	40.21	1.42	20.1	115.2
6.4	-6.0		316.2	47.5	156.0	1.58	31.9	47.22	1.52	23.6	113.9
12.0	-8.1		314.9	46.2	183.0	1.85	32.2	47.53	1.52	23.0	115.4
36.2	-8.6		314.9	46.2	197.2	1.99	32.6	48.05	1.52	24.0	115.7
39.0	-8.9		317.6	48.9	224.0	2.27	33.0	48.50	1.55	24.3	113.1
52.6	-9.1		316.9	48.2	249.1	2.52	33.7	49.41	1.55	24.7	114.3
			318.3	49.6	313.5	3.17	33.7	49.00	1.56	24.5	112.7
			316.9	48.2	376.7	3.01	33.3	48.10	1.54	24.1	113.7
			323.0	55.1	380.0	3.04	28.3	40.93	1.50	20.5	103.1
			320.0	51.3	396.0	4.01	23.9	34.50	1.40	17.2	103.7
			328.7	59.9	429.0	4.34	45.0	65.90	1.05	32.9	110.0
			331.4	62.7	470.2	4.75	53.0	75.92	2.01	38.0	113.1
			332.1	63.4	546.0	5.52	62.5	00.01	2.19	44.4	110.0
			332.0	64.1	606.0	6.94	75.0	104.90	2.42	52.5	126.2
LENGTH,INITIAL,cm		10.06	320.7	59.9	773.0	7.01	01.1	112.44	2.44	56.2	134.1
DIAMETER,cm		4.70									
AREA,INITIAL,cm2		17.95									
VOLUME,INITIAL,cc		100.6									
CONS. VOLUME CHANGE,		9.1									
VOLUMETERIC STRN,cc		0.05									
LENGTH,CONS.cm		9.09									
AREA,CONS.,cm2		17.34									
CONS.VOLUME,cc		171.4									
PROVING RING kg/div		0.266									
EFF.CELL PRESS.kPa		137.0									

stopped overnight at 3.01%
morning restarted at 3.04%

CYCLE C

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384

Sample Number: BH 3 SA 5 & 6

Sample A: Sa. 5
Sample B: Sa. 6
Sample C: Sa. 5

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	544.3	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	275.6
0.5	-1.6		315.6	46.8	7.1	0.07	57.1	14.05	1.06	7.0	235.8
1.0	-2.2		323.8	55.1	10.0	0.10	81.3	20.00	1.09	10.0	230.5
1.5	-3.0		330.0	61.3	23.8	0.24	106.3	26.11	1.12	13.1	227.3
2.0	-3.9		334.8	66.1	29.0	0.29	142.9	35.00	1.17	17.5	227.0
2.5	-4.7		339.0	70.3	40.9	0.42	181.5	44.50	1.22	22.2	227.6
3.0	-5.6		345.9	77.2	45.9	0.47	245.9	60.26	1.30	30.1	228.6
4.0	-7.0		356.2	87.5	52.5	0.53	313.0	76.65	1.41	38.3	226.4
6.9	-10.1		368.6	99.9	64.8	0.66	409.0	100.04	1.57	50.0	225.7
7.7	-11.0		386.5	117.8	91.0	0.92	534.3	130.34	1.83	65.2	222.9
10.8	-12.0		399.6	130.9	119.0	1.21	616.7	150.01	2.04	75.0	219.7
13.2	-12.4		411.3	142.6	155.1	1.57	695.0	168.42	2.27	84.2	217.2
33.9	-12.4		418.9	150.2	200.5	2.04	771.0	185.97	2.48	93.0	218.4
LENGTH,INITIAL,cm		10.00	422.4	153.6	254.1	2.58	849.1	203.67	2.67	101.8	223.8
DIAMETER,cm		4.78	426.5	157.8	307.5	3.12	912.0	217.54	2.85	108.8	226.6
AREA,INITIAL,cm2		17.95	423.7	155.0	328.2	3.33	927.0	220.64	2.83	110.3	230.9
VOLUME,INITIAL,cc		180.91	421.7	153.0	332.2	3.37	937.0	222.92	2.82	111.5	234.1
CONS. VOLUME CHANGE,		12.40	415.5	146.8	357.0	3.62	1006.0	238.72	2.85	119.4	248.2
VOLUMETERIC STRN,cc		0.07	420.3	151.6	396.7	4.03	1041.0	245.99	2.98	123.0	247.0
LENGTH,CONS.cm		9.85	420.3	151.6	444.0	4.51	1073.0	252.28	3.03	126.1	250.2
AREA,CONS.,cm2		17.13	419.6	150.9	489.8	4.97	1104.1	258.33	3.07	129.2	253.9
CONS.VOLUME,cc		168.51	418.2	149.5	535.0	5.43	1135.0	264.28	3.10	132.1	258.2
PROVING RING kg/div		0.043	414.8	146.1	585.0	5.94	1165.0	269.80	3.08	134.9	264.4
EFF.CELL PRESS.kPa		275.6	413.4	144.7	636.0	6.46	1197.0	275.69	3.11	137.8	268.8
			411.3	142.6	707.3	7.18	1239.0	283.15	3.13	141.6	274.6
stopped overnight at 3.12%			407.9	139.2	738.0	7.49	1256.0	286.88	3.10	143.0	279.5
morning restarted at 3.33%											

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS
Project Number: 861-1384
Sample Number: BH 4 SA 7 (Multi-Stage Test)

Sample A: A
Sample B: B
Sample C: C

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Effective Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	337.6	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	68.9
0.5	-0.6		275.6	6.9	23.3	0.32	9.1	3.59	1.06	1.8	63.8
1.0	-0.9		275.6	6.9	29.9	0.41	39.0	15.38	1.25	7.7	69.7
1.5	-1.2		288.7	20.0	44.8	0.61	85.7	33.73	1.69	16.9	65.8
2.0	-1.6		294.9	26.2	61.2	0.83	114.2	44.85	2.05	22.4	65.1
2.5	-1.8		297.0	28.2	76.9	1.05	133.0	52.12	2.28	26.1	66.7
3.0	-2.0		301.1	32.4	92.0	1.25	150.1	58.70	2.61	29.3	65.9
3.5	-2.2		302.5	33.8	110.0	1.50	168.0	65.54	2.86	32.8	67.9
4.7	-2.8		303.2	34.4	134.5	1.83	189.2	73.56	3.13	36.8	71.2
9.6	-3.8		303.2	34.4	154.0	2.09	205.5	79.68	3.31	39.8	74.3
35.5	-3.8		303.2	34.4	190.0	2.58	233.0	89.89	3.61	44.9	79.4
			303.2	34.4	215.3	2.93	252.3	96.99	3.82	48.5	82.9
Stage Number 1			302.5	33.8	242.0	3.29	270.0	103.72	3.95	51.9	87.0
LENGTH,INITIAL,cm		7.470	302.5	33.8	272.0	3.70	289.0	110.22	4.14	55.1	90.2
DIAMETER,cm		3.740	302.5	33.8	292.0	3.97	301.0	114.47	4.26	57.2	92.4
AREA,INITIAL,cm2		10.987	302.5	33.8	312.2	4.24	312.6	118.54	4.37	59.3	94.4
VOLUME,INITIAL,cc		82.075	298.3	29.6	335.0	4.55	324.0	122.47	4.12	61.2	100.5
CONS. VOLUME CHANGE,		3.8									
VOLUMETERIC STRN,cc		0.046									
LENGTH,CONS.cm		7.355									
AREA,CONS.,cm2		10.648									
CONS.VOLUME,cc		78.275									
PROVING RING kg/div		0.043									
EFF.CELL PRESS.kPa		68.9									

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384

Sample Number: BH 4 SA 7 (Multi-Stage Test)

Sample A: A

Sample B: B

Sample C: C

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	406.5	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	137.8
0.5	0.0		290.8	22.0	4.0	0.06	65.0	24.94	1.22	12.5	128.2
1.0	-0.1		297.6	28.9	7.5	0.11	99.0	37.96	1.35	19.0	127.8
1.5	-0.2		306.6	37.9	13.2	0.19	134.0	51.34	1.51	25.7	125.6
2.0	-0.4		314.2	45.5	24.0	0.34	181.0	69.24	1.75	34.6	126.9
5.0	-0.8		319.0	50.3	38.0	0.55	224.9	85.86	1.98	42.9	130.4
6.8	-1.1		328.7	59.9	52.3	0.75	263.3	100.32	2.29	50.2	128.0
8.6	-1.3		329.3	60.6	67.3	0.97	298.7	113.56	2.47	56.8	133.9
31.7	-1.7		331.4	62.7	81.0	1.16	325.0	123.31	2.64	61.7	136.8
			333.5	64.8	88.0	1.26	337.5	127.93	2.75	64.0	137.0
			334.2	65.5	97.0	1.39	353.1	133.66	2.85	66.8	139.2
			335.5	66.8	110.8	1.59	373.0	141.22	2.99	70.6	141.6
			335.5	66.8	128.2	1.84	398.2	150.85	3.11	75.0	146.0
			336.2	67.5	154.5	2.22	428.5	160.85	3.29	80.4	150.7
			336.9	68.2	171.4	2.46	445.1	166.67	3.39	83.3	152.9
			336.2	67.5	191.0	2.74	463.0	172.87	3.46	86.4	156.7
			334.8	66.1	210.3	3.02	479.1	178.37	3.49	89.2	160.8

Stage 2

LENGTH,INITIAL,cm	7.02
DIAMETER,cm	3.77
AREA,INITIAL,cm2	11.15
VOLUME,INITIAL,cc	78.2
CONS. VOLUME CHANGE,	1.7
VOLUMETERIC STRN,cc	0.02
LENGTH,CONS.cm	6.97
AREA,CONS.,cm2	10.99
CONS.VOLUME,cc	76.5
PROVING RING kg/div	0.043
EFF.CELL PRESS.kPa	137.8

CYCLE C

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384

Sample Number: BH 4 SA 7 (Multi-Stage Test)

Sample A: A

Sample B: B

Sample C: C

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	544.3	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	275.6
0.5	-0.1		281.1	12.4	2.4	0.04	75.8	28.47	1.11	14.2	277.4
1.0	-0.1		297.0	28.2	4.0	0.06	130.0	48.82	1.20	24.4	271.8
1.5	-0.2		309.4	40.7	6.2	0.09	187.0	70.20	1.30	35.1	270.0
2.0	-0.2		331.4	62.7	12.7	0.19	287.0	107.64	1.51	53.8	266.7
8.3	-1.2		351.4	82.7	22.7	0.34	379.0	141.94	1.74	71.0	263.9
32.7	-1.4		371.4	102.7	38.4	0.57	474.0	177.10	2.02	88.5	261.5
			385.2	116.4	54.2	0.80	544.5	202.96	2.28	101.5	260.6
			391.3	122.6	66.0	0.98	586.5	218.23	2.43	109.1	262.1
			411.3	142.6	139.0	2.06	756.0	278.23	3.09	139.1	272.1
			412.7	144.0	176.0	2.61	807.0	295.34	3.24	147.7	279.3
			414.1	145.4	197.0	2.92	830.0	302.79	3.33	151.4	281.6
Stage 3			412.7	144.0	238.2	3.53	871.0	315.75	3.40	157.9	289.5
LENGTH,INITIAL,cm		6.81	412.0	143.3	284.0	4.20	909.0	327.21	3.47	163.6	295.9
DIAMETER,cm		3.81	398.9	130.2	321.0	4.75	752.8	269.43	2.85	134.7	280.1
AREA,INITIAL,cm2		11.41	432.7	164.0	323.9	4.80	825.3	295.25	3.64	147.6	259.2
VOLUME,INITIAL,cc		77.69	433.4	164.7	325.4	4.82	847.5	303.12	3.73	151.6	262.5
CONS. VOLUME CHANGE,		1.90	441.6	172.9	330.0	4.89	878.0	313.80	4.00	156.9	259.6
VOLUMETERIC STRN,cc		0.02	427.9	159.2	336.3	4.98	896.3	320.83	3.75	160.0	276.5
LENGTH,CONS.cm		6.75	427.9	159.2	340.1	5.03	908.3	324.12	3.78	162.1	278.5
AREA,CONS.,cm2		11.22	428.6	159.8	343.9	5.09	915.0	326.32	3.82	163.2	278.9
CONS.VOLUME,cc		75.79	427.9	159.2	348.3	5.16	922.8	328.88	3.82	164.4	280.9
PROVING RING kg/div		0.043	419.6	150.9	355.3	5.26	932.1	331.82	3.66	165.9	290.6
EFF.CELL PRESS.kPa		275.6	425.1	156.4	361.0	5.34	938.0	333.63	3.80	166.8	286.0
			420.3	151.6	367.5	5.44	943.8	335.35	3.70	167.7	291.7
stopped weekend at 4.20%			413.4	144.7	398.0	5.89	964.2	340.97	3.60	170.5	301.4
restarted at 4.75%			410.0	141.2	434.1	6.43	984.0	345.99	3.58	173.0	307.3
			407.9	139.2	472.9	7.00	1002.0	350.16	3.57	175.1	311.5
			401.0	132.3	505.0	7.48	1015.2	352.96	3.46	176.5	319.8
			398.9	130.2	596.0	8.82	1052.0	360.43	3.48	180.2	325.6
			394.1	125.4	667.2	9.88	1071.8	362.96	3.42	181.5	331.7
			392.0	123.3	722.0	10.69	1088.9	365.44	3.40	182.7	335.0

CYCLE A

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384
Sample Number: BH 8 SA 8 & 9

Sample A: Sa. 8
Sample B: Sa. 8
Sample C: Sa. 9

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	337.6	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	68.9
0.5	-0.8		291.4	22.7	18.7	0.19	1.1	1.64	1.04	0.8	47.0
1.0	-1.2		290.1	21.4	29.2	0.29	3.9	5.81	1.12	2.9	50.4
2.0	-1.8		288.7	20.0	38.7	0.38	5.5	8.18	1.17	4.1	53.0
3.0	-2.2		294.2	25.5	43.5	0.43	6.9	10.26	1.24	5.1	48.5
4.0	-2.4		291.4	22.7	49.0	0.49	8.8	13.07	1.28	6.5	52.7
31.3	-3.8		292.8	24.1	53.2	0.53	9.6	14.26	1.32	7.1	51.9
			295.6	26.9	58.4	0.58	10.8	16.03	1.38	8.0	50.0
			294.9	26.2	65.5	0.65	12.1	17.95	1.42	9.0	51.7
			294.9	26.2	74.1	0.73	13.9	20.60	1.48	10.3	53.0
			294.2	25.5	86.1	0.85	16.2	23.90	1.55	12.0	55.4
			295.6	26.9	103.1	1.02	19.2	28.37	1.67	14.2	56.2
			294.2	25.5	118.5	1.17	22.0	32.46	1.75	16.2	59.6
LENGTH,INITIAL,cm	10.160		294.2	25.5	134.0	1.33	24.0	36.53	1.84	18.3	61.7
DIAMETER,cm	4.750		291.4	22.7	166.5	1.65	30.0	44.05	1.95	22.0	68.2
AREA,INITIAL,cm2	17.723		293.5	24.8	193.0	1.91	34.0	49.79	2.13	24.9	69.0
VOLUME,INITIAL,cc	180.064		289.4	20.7	227.0	2.25	38.8	56.62	2.17	28.3	76.5
CONS. VOLUME CHANGE,	3.8		289.4	20.7	266.0	2.64	44.0	63.96	2.33	32.0	80.2
VOLUMETERIC STRN,cc	0.021		285.9	17.2	291.0	2.88	47.0	68.14	2.32	34.1	85.7
LENGTH,CONS.cm	10.088		284.6	15.8	330.0	3.27	51.9	74.95	2.41	37.5	90.5
AREA,CONS.,cm2	17.473		281.8	13.1	374.0	3.71	56.3	80.94	2.45	40.5	96.3
CONS.VOLUME,cc	176.264		281.1	12.4	405.5	4.02	59.6	85.40	2.51	42.7	99.2
PROVING RING kg/div	0.266		280.4	11.7	415.0	4.11	60.0	85.89	2.50	42.9	100.1
EFF.CELL PRESS.kPa	68.9		288.7	20.0	418.0	4.14	54.1	77.42	2.50	38.7	87.6
			281.8	13.1	428.0	4.24	59.5	85.06	2.52	42.5	98.3
stopped overnight at 4.11%			281.8	13.1	448.0	4.44	63.2	90.16	2.62	45.1	100.9
morning restarted at 4.14%			278.4	9.6	461.1	4.57	64.0	91.18	2.54	45.6	104.8
			276.3	7.6	509.0	5.05	67.0	94.98	2.55	47.5	108.8
			274.2	5.5	568.2	5.63	72.0	101.44	2.60	50.7	114.1
			272.8	4.1	580.4	5.75	72.2	101.59	2.57	50.8	115.6
			270.8	2.1	650.0	6.44	75.0	104.75	2.57	52.4	119.2
			269.4	0.7	677.0	6.71	75.9	105.57	2.55	52.8	121.0

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384
Sample Number: BH 8 SA 8 & 9

Sample A: Sa. 8
Sample B: Sa. 8
Sample C: Sa. 9

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	406.5	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	137.0
0.5	-1.1		275.6	6.9	5.9	0.06	67.7	16.79	1.13	8.4	139.3
1.0	-1.8		277.0	8.3	14.5	0.15	74.3	18.42	1.14	9.2	138.7
1.5	-2.6		282.5	13.8	43.3	0.44	105.6	26.10	1.21	13.0	137.1
2.0	-3.1		293.5	24.8	60.0	0.62	191.0	47.12	1.42	23.6	136.6
2.5	-3.8		308.7	40.0	79.3	0.81	291.0	71.65	1.73	35.8	133.7
3.0	-4.4		315.6	46.8	97.3	1.00	341.2	83.85	1.92	41.9	132.9
4.0	-5.5		323.8	55.1	145.0	1.49	433.0	105.88	2.28	52.9	135.6
5.0	-6.5		328.7	59.9	183.9	1.89	490.9	119.56	2.54	59.8	137.6
6.0	-7.0		330.0	61.3	227.0	2.33	550.0	133.34	2.74	66.7	143.2
8.0	-7.7		330.0	61.3	270.0	2.77	603.1	145.56	2.90	72.8	149.3
11.0	-8.1		330.0	61.3	290.0	2.98	624.2	150.33	2.97	75.2	151.6
13.4	-8.2		316.2	47.5	304.0	3.12	559.5	134.55	2.49	67.3	157.5
21.6	-8.4		323.1	54.4	314.1	3.23	678.0	162.87	2.95	81.4	164.8
37.4	-8.7		321.0	53.0	361.0	3.71	731.0	174.73	3.06	87.4	172.1
			318.3	49.6	413.0	4.25	773.4	183.82	3.00	91.9	180.1
			316.9	48.2	465.9	4.79	813.0	192.16	3.15	96.1	185.6
			313.5	44.8	537.0	5.52	860.0	201.69	3.17	100.8	193.9
			310.0	41.3	605.1	6.22	898.0	209.06	3.17	104.5	201.0
			309.4	40.7	643.0	6.60	918.3	212.90	3.19	106.4	203.6
LENGTH,INITIAL,cm	9.90		304.5	35.8	705.0	7.24	950.3	218.81	3.15	109.4	211.4
DIAMETER,cm	4.73		304.5	35.8	719.1	7.39	957.1	220.03	3.16	110.0	212.0
AREA,INITIAL,cm2	17.57										
VOLUME,INITIAL,cc	174.0										
CONS. VOLUME CHANGE,	8.7										
VOLUMETERIC STRN,cc	0.05										
LENGTH,CONS.cm	9.73										
AREA,CONS.,cm2	16.99										
CONS.VOLUME,cc	165.3										
PROVING RING kg/div	0.043										
EFF.CELL PRESS.kPa	137.8										

stopped overnight at 3.12%
morning restarted at 3.23%

CYCLE C

CONSOLIDATED UNDRAINED TRIAXIAL WITH PORE PRESSURE MEASUREMENTS

Project Number: 861-1384
Sample Number: BH 8 SA 8 & 9

Sample A: Sa. 8
Sample B: Sa. 8
Sample C: Sa. 9

Square Root of Time min	Total Volume Change cc	Cell Pressure kPa	Total P.W.P kPa	Changed P.W.P kPa	Strain Dial Reading .01 mm	Axial Strain %	Stress Dial Reading .002 mm	Deviator Stress kPa	Effective Principal Stress Ratio	Shear Stress kPa	Effective Normal Stress kPa
0.0	0.0	544.3	268.7	0.0	0.0	0.00	0.0	0.00	1.00	0.0	275.6
0.5	-3.8		280.4	11.7	3.5	0.04	30.0	45.75	1.17	22.9	286.8
1.0	-5.0		299.0	30.3	10.0	0.10	51.2	78.02	1.32	39.0	284.3
1.5	-5.6		319.7	51.0	20.5	0.21	71.0	108.08	1.48	54.0	278.6
2.0	-6.4		341.1	72.3	40.0	0.40	94.0	142.81	1.70	71.4	274.7
2.5	-7.0		362.4	93.7	69.5	0.70	116.2	176.01	1.97	88.0	269.9
3.0	-8.0		372.1	103.3	94.3	0.95	131.1	198.07	2.15	99.0	271.3
4.0	-9.2		381.0	112.3	124.9	1.26	145.1	218.54	2.34	109.3	272.6
5.0	-10.0		383.1	114.4	144.4	1.46	152.5	229.23	2.42	114.6	275.8
6.0	-10.5		389.3	120.6	195.0	1.97	168.3	251.67	2.62	125.8	280.9
8.0	-11.1		390.0	121.3	233.9	2.36	178.7	266.15	2.72	133.1	287.4
12.7	-11.6		389.3	120.6	276.5	2.79	187.9	278.62	2.80	139.3	294.3
34.2	-11.7		389.3	120.6	318.3	3.21	195.0	287.89	2.86	143.9	299.0
LENGTH,INITIAL,cm		10.12	387.9	119.2	337.0	3.40	199.0	293.22	2.87	146.6	303.0
DIAMETER,cm		4.77	392.7	124.0	343.8	3.47	177.5	261.35	2.72	130.7	282.3
AREA,INITIAL,cm2		17.87	388.6	119.9	363.0	3.67	207.1	304.33	2.95	152.2	307.9
VOLUME,INITIAL,cc		180.87	382.4	113.7	407.0	4.11	215.2	314.77	2.94	157.4	319.3
CONS. VOLUME CHANGE,		11.70	382.4	113.7	455.1	4.60	222.0	323.07	3.00	161.5	323.4
VOLUMETERIC STRN,cc		0.06	376.2	107.5	502.1	5.07	227.9	330.01	2.96	165.0	333.1
LENGTH,CONS.cm		9.90	375.5	106.8	560.7	5.74	235.0	337.88	3.00	168.9	337.7
AREA,CONS.,cm2		17.10	371.4	102.7	628.0	6.34	240.5	343.59	2.99	171.8	344.7
CONS.VOLUME,cc		169.17	371.4	102.7	660.8	6.67	243.1	346.87	3.00	173.0	346.0
PROVING RING kg/div		0.266	367.9	99.2	715.9	7.23	247.3	349.95	2.98	175.0	351.4
EFF.CELL PRESS.kPa		275.6	367.9	99.2	730.0	7.37	248.5	351.11	2.99	175.6	351.9

stopped overnight at 3.47%
morning restarted at 3.67%